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SEVEN LEVEL CASCADED MULTILEVEL INVERTER

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Abstract:

The use of multilevel inverters in high-power, high-voltage applications is generally acknowledged. Reverse voltage topology is applied here. Compared to current inverters, this design requires fewer components, carrier signals, and gate drivers. Consequently, there is a significant reduction in total cost and complexity, especially for higher output voltage levels. In comparison to traditional topologies, this topology requires fewer components. Two components make up the output voltage: the polarity generation section and the level generation part, which generates various levels using high frequency switches. The polarity creation component creates the output voltage's polarity, and the level generation part generates various levels using high frequency switches. Due to the inverter's component that runs the switching power devices at line frequency, it is also more efficient. Consequently, there not all switches must operate at high frequency, resulting in easier and more dependable control over the inverter. Ultimately, a seven-level topology prototype.

Keywords —**Multilevel inverter distortion, FPGA Modulation techniques, Selective harmonic elimination, Total harmonic.**

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I. INTRODUCTION

An inverter is a dc-to-ac converter that produces specified output voltage and frequency.

The inverters can be broadly divided into two categories based on how they operate:

1) voltage Source Inverter (VSI)
2) Current Source Inverter (CSI)

An inverter with a voltage waveform as its controlled ac output is known as a voltage source inverter. An inverter with a regulated ac output that is a current waveform is called a current source inverter. Using a cascaded H Bridge topology, we have constructed a five-level voltage source inverter in this project. Use of sinusoidal pulse width modulation was made in the switching strategy.Adjustable speed AC drives, induction heating powered by aircraft power supply, UPS (Uninterruptible power supplies) for PCs, HVDC transmission lines, and other industrial uses for inverters are a few examples.

The dc supply voltage in voltage-regulated converters causes the semiconductor devices, which include power MOSFETs, IGBTs, GTOs, and other self-controlled forward or asymmetric blocking devices, to always be forward biased. Although force-commutated thyristor circuits were once in use, they are no longer in use. The gadget is constantly linked across a feedback diode to allow for free flow of reverse current. The fact that the load parameters have no effect on the AC-fabricated voltage wave is one of a voltage fed converter's key features.

II. MULTILEVEL INVERTERS

An output voltage waveform from a multilevel inverter has more than two levels. In recent years, power apparatus has become necessary for many industrial applications. One medium voltage motor drive is a utility application that needs a medium voltage and megawatt power level for a medium voltage grid; connecting a single power

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semiconductor switch directly causes problems for someone. Consequently, a multilayer power converter has been presented as a high power, medium voltage substitute. In addition to having high power ratings, a multilevel convener makes it possible to use renewable energy sources. For high power applications, a multilevel converter system can be easily interfaced with renewable energy sources including photovoltaic, wind, and fuel cells.

Since 1975, the idea of multilayer converters has been presented. The three-level converter gave rise to the word "multilevel." Many multilayer converter topologies have now been created. To achieve higher power, a multilevel converter's basic idea is to employ a sequence of power semiconductor switches with many lower voltage sources to convert power by creating a voltage waveform like a staircase. Multiple DC voltage sources such as batteries, capacitors, and renewable energy sources can be employed in that sequence. To produce high voltage at the output, the power switches are commutated, aggregating these various dc sources; nonetheless, the rated voltage sources to which they are linked remain unchanged.

A. MULTILEVEL INVERTER TOPOLOGIES

Over the past 20 years, numerous multilevel convener topologies have been presented. Modern studies have focused on innovative modulation techniques and converter topologies. Furthermore, the literature has reported on three distinct primary multilevel converter topologies:

1) Diode clamped (neutral -clamped)
2) Flying capacitors (capacitors clamped) and
3) Cascaded H-bridge converter with separate dc sources

All possess the sane attribute. This is that the typical bandwidth restriction brought about by the switching frequency can be reexamined and the output filter drastically decreased. Furthermore, a variety of modulation techniques and control paradigms, including space vector modulation (SVM), selective harmonic elimination (SHE-PWM), and sinusoidal pulse width modulation (SPWM), have been developed for multilevel converters. Furthermore, a lot of multilayer converter applications concentrate on utility interface for renewable energy systems, traction drive systems, flexible AC transmission systems (FACTS), and industrial medium-voltage motor drives.

III. NEUTRAL POINT CLAMPED INVERTER

The point of neutrality Series-connected capacitors are used in clamped or diode-clamped multilevel inverters to split the DC bus voltage into a range of voltage levels. The DC bus requires (m-1) capacitors in order to generate a (m) level diode clamp inverter. Diode-clamped multilevel inverter topologies are employed in this research. Figure depicts the three-phase multilevel inverter's power circuit configuration.

It is a variation on the fundamental multilevel inverter arrangement, where the full-bridge switching element is made up of an auxiliary circuit. The neutral point is formed when the dc source splits into two equal halves due to capacitor banks. for every heartbeat. A single terminal auxiliary circuit is connected to the phase-leg center in question. Only three active neutral points in total. while the corresponding phase-leg's center is connected to the other terminal of the auxiliary circuit. Per phase leg, a maximum of three active switches are employed.

The following benefits are offered by this second kind of converter:

1) The distortion level is so minimal when M is very high that filters are not needed.

2) Because there is a chance that the switching frequency will be lower than 500 Hz (i.e., switching at the line frequency), there are fewer restrictions on the switches.

3) The flow of reactive power is controllable.

The Main Disadvantages are:

1) The number of diodes becomes excessively high with the increase in level.

2) It is more difficult to control the power flow of each converter.

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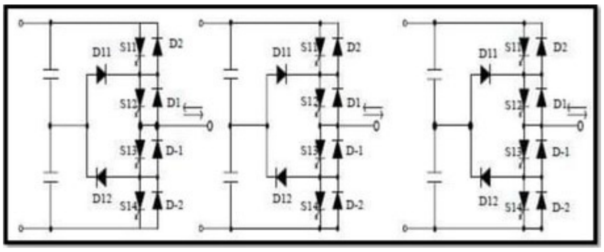


(Fig. Diode clamped Multilevel Inverter)

B. Flying capacitor inverter

1) Mode 1

Figure shows the structure of a flying capacitor type converter. We notice that compared to NPC-type converters a high number of auxiliary capacitors are needed for, M level(M-1) main capacitors and (M-1) *(M-2)/2 auxiliary capacitors.

The main advantages of this type of converter are:

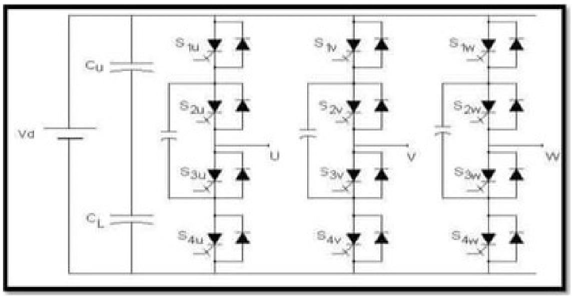
1) For a high M level, the use of a filter is unnecessary.

2) Control of active and reactive power flow is possible.

The drawbacks are:

1) The number of capacitors is very high.

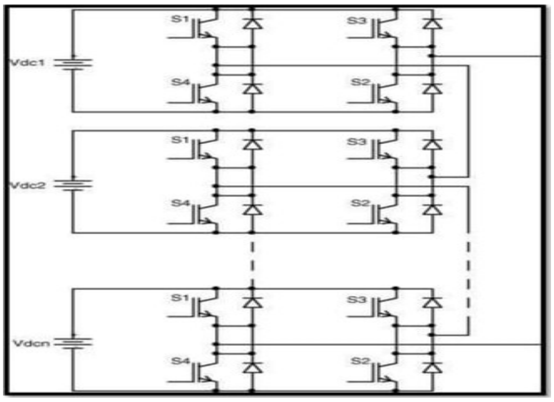
2) Control Of the system becomes difficult with the increase of M.



(Fig: Flying capacitor type Multi Level Inverter)

2) Cascaded type multilevel inverter

This type of converter does not need any transformer clamping diodes or flying capacitors; each bridge converter generates three level of voltages (E; O, and YE). For a three-phase configuration, the cascaded converters can be connected in star or Delta. It has the following Advantages: It uses fewer components that the other types. It has a simple control, since the converters present the same structure. However, the main drawbacks is that it needs separate dc source for the conversion of the active power, which limits its use. Its configuration can be represented as.



(Fig. Cascaded H- Bridge Multi Level Inverter)

C. Three level inverter

A three-level inverter is a modification of basic two-level inverter. The topology used here is that of cascaded H bridge inverter. In this separate DC sources are used for each H bridge. If the value of DC voltage is same in all the bridges, then it can simply be called as a cascaded multilevel inverter. In case of different DC voltage being used in different H bridges, then it is called a Hybrid multilevel inverter.

D. Five level inverter

Figures In tie Five Level Inverter model, the following scheme has been implemented:

1) Switching scheme- Sinusoidal PWM
2) Power Supply -100V DC each
3) Switches – IGBT
4) Load- R-load
5) Measurements

E. Seven level inverter

Reverse voltage topology

In conventional multilevel inverters, the power semiconductor switches are combined to produce a high frequency waveform in positive and negative polarities. However, there is no need to utilize all the switches for generating bipolar levels. This idea has been put into practice by the reverse voltage topology. This topology is a hybrid multilevel topology which separates the output voltage into two parts. One part is named level generation part and is responsible for level generating in positive

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polarity. This part requires high-frequency switches to generate the required levels. The switches in this part should have high-switching-frequency capability. The other part is called polarity generation part and is responsible for generating the polarity of the output which is the low-frequency part operating at line frequency. The topology combines the two parts (high frequency and low frequency) to generate the multilevel voltage output.

In order to generate a complete multilevel output, the positive levels are generated by the high-frequency part (level generation), and then, this part is fed to a full-bridge inverter (polarity generation), which will generate the required polarity for the output. This will eliminate many of the semiconductor switches which were responsible to generate the output voltage levels in positive and negative polarities. The RV topology in seven levels is shown in Figure As can be seen, it requires ten switches and three isolated sources. The principal idea of this topology as a multilevel inverter is that the left stage in Figure generates the required output levels (without polarity) and the right circuit full bridge converter decides about the polarity of the output voltage. This part, which is named polarity generation, transfers the required output level to the output with the same direction or opposite direction according to the required output polarity. It reverses the voltage direction when the voltage polarity requires to be changed for negative polarity. It can also be applied for three-phase applications with the same principle. This topology uses isolated dc supplies. Therefore, it does not face voltage balancing problems due to fixed dc voltage values. In comparison with a cascaded topology, it requires just one-third of isolated power supplies used in a cascade type inverter. This topology is well suited for a 3-phase system

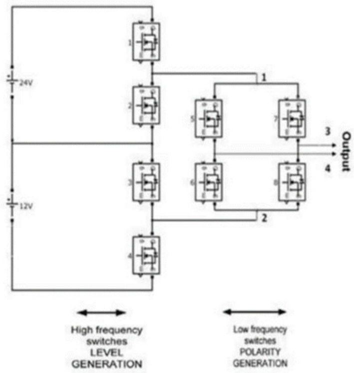
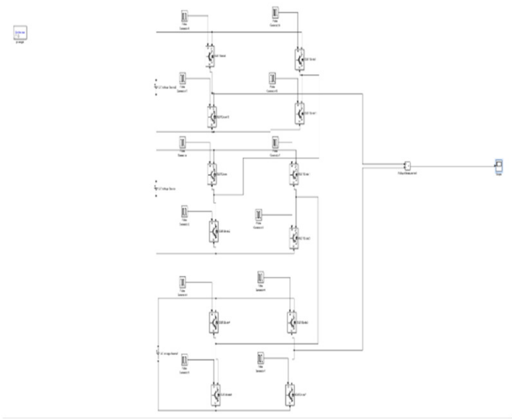


Fig: Generalized 7 level inverter

F. *Simulation model*



(Fig. Simulation model of 7 level inverter)

G. *Simulation result*

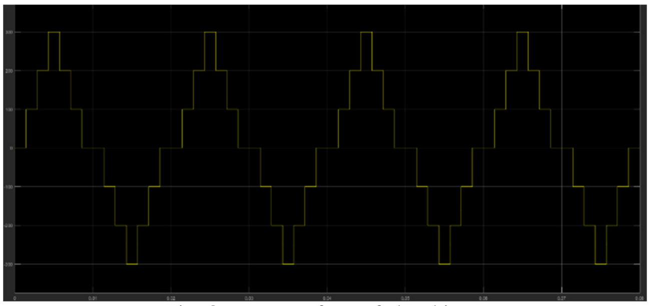


Fig: Output waveform of7 level inverter

H. *FFT analysis*

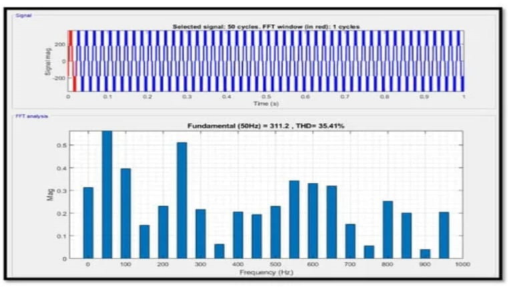


Fig: FFT Analysis of voltage signal

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CONCLUSION & DISCUSSION

In this project of Three-phase Five-cascaded H Bridge inverter is carried out using sinusoidal Pulse Width Modulation Technique through MATLAB / Simulink, in this Project, Five-Levels of AC output Voltage are generated using a Five-level Inverter. Efficiency and losses of the five-level inverter has been carried out in this Project. Earlier simulation three phase three level inverter result has been compared to three phase five level inverter and it is found that total harmonic distortion been reduced by 21.1% and efficiency has been increased by 2.44%. As the number of level increases, THD decreases power increases. The output waveforms of the voltage and local current are also approximated sine wave.

Increasing the number of voltage levels in the inverter without requiring higher rating on individual devices can increase power rating. The unique structure of multilevel voltage source inverters allows them to reach high voltages with low harmonics without the use of transformers or series-connected synchronized -switching devices. The harmonic content of the Output voltage decreases significantly.

FUTURE SCOPE

The total harmonic distortion can be decreased by increasing the level of the inverter so we can go for more levels to get the best output with zero or minimum distortion. The control technique for multilevel power converters can be further implemented using more efficient mean such as a Space Vector Pulse Width Modulation and it can be further generalized to higher levels and other classes of power conveners and inverters. The levels of multilevel configuration can be increased and further improvements in terms of performance and power quality issues can be broadly studied and could be implemented with hardware circuits.

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