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Reduction of Total Harmonic Distortion Using 27 Level Multilevel Inverter with 3 DC Source

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ABSTRACT-

Sun-based photovoltaic (PV) power frameworks are obtainable in sustainable power frameworks, and crossover PV-battery frameworks or energy stockpiling frameworks (ESS) are better suited for providing uninterruptible capacity to the neighbourhood fundamental obligations during lattice side shortfalls. This energy storage framework also improves the framework elements during power fluctuations. The study of the hybrid inverter has been done in this paper, which clarifies all the features such as usage, pros, and cons of mixed inverter. A multilayer inverter has numerous advantages over ordinary inverters, such as reduced voltage THD and current THD. In a cascaded H bridge inverter, a stepped ac voltage waveform is obtained. The requirement for filters is reduced because the voltage output of the multilayer inverter is a stepped wave that resembles a completely sinusoidal ac voltage. In addition, because the number of filters required is reduced, the overall cost and volume of the system are lowered. Because a multilayer inverter connects a dc source to each stage, this technology is appealing for the application of solar photovoltaic panels, which also generate electricity in stages. A 27-level inverter is designed in MATLAB Simulink in this research. The total harmonic distortion in the findings demonstrates the design's correctness.

Key words: Harmonics, Inverter, Multilevel Inverter.

1. INTRODUCTION

One of the most encouraging sources of environmentally friendly energy is the Sun. Sun energy can be used to generate both power and heat. It is not hazardous to the environment, and switching to it has no negative consequences. [11] Solar energy frameworks are rapidly expanding over the planet. When in doubt, pick an elite inverter (high explicit force, high productivity, high force factor, and so on), as evidenced by sinusoidal voltage bend, recurrence, and voltage dependability. For maximum power, a low-frequency channel should be used. As a result, the sun-powered board inverter serves as the core of a solar-powered ranch, converting DC to AC. [1] Multilevel inverter (MLI) regions, for example, have acquired ubiquity in mechanical applications in recent years due to superior power quality analysis than its typical two-level partner. Its significance is enhanced by lower harmonic distortion, improved back sine wave quality, and lower switching voltage. [2] MLI topologies have numerous advantages over conventional topologies, including low voltage-stress on switches, low voltage-ratings, lower THD, lower electromagnetic interference (EMI), voltage boosting capability in single-stage operation, and improved power-quality of the grid-integrated system with fewer filter passive elements. MLI topologies are classified into three types: cascaded H-bridge (CHB-MLI), NPC-MLI, and flying capacitor (FC-MLI). Despite the high number of yield voltage levels that may be derived from these topologies, many power switches are required, which increases converter power loss, complicates control circuit design and implementation, and reduces inverter dependability. Modified MLI designs with fewer components are introduced to address past problems.

The idea behind multilevel inverter technology is that by connecting many H-Bridge inverters in series, stepped ac voltage may be produced by properly switching the switches. As the number of H-bridges in the cascaded multilayer inverter increases, the yield voltage rises several steps and approaches pure sinusoidal ac voltage. FACTS and hybrid solar systems are two high-power applications that make use of the multilayer inverter. The number of filters required lowers as the number of voltage levels increases, while the total efficiency of the system increases as harmonics decrease. Multilevel inverter technology is based on the fact that by connecting numerous H- Bridge inverters in series, stepped alternating current voltage can be generated by correctly switching the switches. As the number of H-bridges in the cascaded multilevel inverter increases, so do multiple steps in the yield voltage, and the yield voltage approaches pure sinusoidal ac voltage. In high-power applications like as hybrid solar systems and FACTS, the multilayer inverter is used. The number of filters required lowers as the number of voltage levels increases; also, as harmonics diminish, the total efficiency of the system increases. Because of the cell structure of a solar photovoltaic system, multilevel inverters are well suited for low power applications where the switching frequency is not constrained and harmonic content can be reduced using manipulate strategies such as multicarrier pulse width modulation and multiple hysteresis band control. Each solar array in a solar PV system generates a different dc voltage. To produce different voltage stages, different H-Bridges can be connected to this voltage source. As a result, adopting a multilayer inverter may be advantageous for fuel cell or solar applications. [3]

MLI are used in almost every aspect of electrical design, such as low- or medium-voltage direct current (HVDC) applications, distributed generation (DG) frameworks, mechanical drive applications, uninterruptible power supply, and so on. They are frequently employed in a range of commercial drives and in many unified areas. MLIs are a kind of power semiconductor devices with varying dc connections that produce a sinusoidal waveform at the output. Neutral Point Clamped (NPC), Flying Capacitor (FC), and Cascade H-Bridge are the three most essential and well-known MLI topologies employed in commercial applications in recent years (CHB). [2]

J. Shen et al. demonstrate how the design and operation of a five-level inverter may inject truly sustainable energy into the grid while lowering exchange failure, symphony distortion, and other issues Interference in the electromagnetic field caused by actions impacting electronic equipment exchange The buck converter, entirely connected inverter, and channels comprise a five-level inverter. The dual buck converter contributes two voltage sources from the DC capacitor. The twin buck converter assists in producing a three-level balanced DC yield voltage from the two DC voltage sources of each capacitor. These are the voltages of the DC capacitor. The output voltage of the dual buck converter ensures the inverter's complete devotion. The output voltage of the dual buck converter ensures the inverter's complete devotion. The power electronic switch of the completely linked inverter is simultaneously coupled with the mains voltage with low repetition accuracy to change the operating voltage of the twin buck converter to a five-step AC voltage. The inverter's five-level operating current is configured so that the sinusoidal current it generates when fed into the network is in phase with the voltage from the power source. A computer model that was constructed was used to verify the numerous age-restricted exposures. The results of the tests show that the age range provided by unlimited power has reached normal. [4] Multi-level inverters are another type of AC/DC switching converter utilised in power, medium voltage, and high voltage systems, according to M. D. Siddique et al. For age-related stepped loads with reduced switching requirements, two additional geographic locations are proposed here. A DC voltage supply and 10 layers are required to organise 15 levels in a stack. The background geography should complement the main geography. It includes four constant voltage sources and twelve variations, totaling 25 power levels. Aside from having fewer switches, the two geographies benefit from lower voltage strains across the switches. This study also contains a detailed comparative analysis of the two geographies to highlight the key features of the proposed geographies. Several test results for this document were withdrawn in order to check the sensitivity of the projected geographic location under varied exposure situations, as well as the dynamic changes in the exposure and adjustment lists. [2] C. Dhanamjayulu and colleagues presented Another single-stage 15-level DC to AC converter with fewer parts for the Solar PV application proposed in this publication. The proposed inverter is used in conjunction with a boost converter. It aids in the separation of energy from the PV module and the creation of 15 ventured yield voltage levels with minimal THD. The recommended dc to ac converter can enhance effectiveness while decreasing mishaps, costs, and complexity of the whole framework. With MPPT, the typical boost converter will sustain the yield voltage (P&O). The proposed dc-to-ac converter is tested provisionally with the DSPACE RTI 1104 regulator and MATLAB/Simulink. Investigate existing multilateral instruments in depth using the proposed dc to ac converter. The work represents experimental results that demonstrate not only its proficiency but also its viability under varied conditions of direct and non-straight loads. The dc to ac converter can adapt effectively to structure-related constructions and is resistant to indirect loads.[5]

Masudul Haider Imtiaz's research demonstrates the execution of an IPS (immediate power supply) framework model to guarantee continuous yield current to stack in private application using both PV energy and AC Grid. PWM dc to ac converter service interface planned here to operate by both solar energy and capacity batteries that significantly answers the necessity in rural areas where National Grids are not really accessible and power cut issue reduces the feasibility of IPS. Instead of using AC power to charge the battery, solar energy is used, which saves many megawatts of electricity per day. It combines particular battery power sensing, microcontroller unit (MCU) charging current regulation, and DC/AC MPPT combined charging to improve battery life and assure the safety of body components (monitoring). Maximum power point) to build the most powerful photovoltaic solar AC modules. Examining the progress of force-interfacing control and the advancement of overall framework activity gives permission to use the proposal in this work. PC simulations and experimental results demonstrate the validity of this proposed framework's high power transformation proficiency and low symphonic distortions. [6] According to Saad et al., the growing interest in energy, rising oil prices, and concerns about environmental repercussions have accelerated the progress of sustainable power sources such as wind, solar, sea, biomass, and geothermal force. Sunlight-based energy is one of the most notable advancements in sustainable assets. With the rapid progress of force electronic techniques, solar energy as an alternative fuel source, for example, photovoltaic (PV) module, has been put to use. The inverter is the principal component responsible for managing the power flow between the module, battery, and load in any solar module-based structure. This article describes fictitious activities for inverter topologies such as PushPull and HBridge.[7] Another location for the multilayer inverter is proposed by V.J.Rupapara et al. In this proposed geography, we are employing two notable geographies as dropped H-connect multilevel inverter geography and integrating it with multi-string staggered inverter geography, as well as suggesting another multilevel inverter geography that is on the base lowered gadget check. The goal of Reduce gadget tally is to reduce the size, expense, and complexity of equipment. Here, with the assistance of these geographies, we may achieve the 31 level, and that too with only ten exchanging gadgets and four dc sources. The reproduction findings depict and validate the functioning nuances of methodology and framework plan of this proposed multilayer inverter architecture. [8]

L. M. Tolbert et al. explain that standard two-stage high frequency pulse width modulation (PWM) dc to ac converters used in motor drives have certain issues with high frequency switching, which results in a change in normal to high voltage (dV / dt) on the motor windings. Your gadget may be able to switch to a lower frequency. To be employed as a power-driven converter, two different layer geographies are distinguished: a coarse inverter with a discrete DC power supply and a series converter with a fixed diode. Because of the potential high VA value and the usage of a certain degree of continuous voltage source from the battery or power module, all electric drives are used in large cars. It has the potential to be used as a hybrid electric car. Reconstruction and test results indicate that these two converters outperform PWM drivers. [9] M. Vasiladiotis et. al. explain Multilevel Converters and battery energy storage systems (BESS) are key segments here and now and in fate medium voltage organizations, where a significant combination of sustainable power sources happens. Modular multilevel converters (MMC) provide the option of inserting these energy storage components separately. This is because there are some sub-modules that can work at a completely lower voltage. This magazine explores alternative working modes for this kind of converter construction. The final sub-module yield flows are interfaced to the batteries through non-secluded DC/DC converters to kill the low frequency regions of the sub-module yield flows. In order to alter the battery's State of Charge, control calculations are created, and the individual addition obstacles are set up. Multilayer inverters have numerous advantages over ordinary inverters, according to Ashwani Singh et al., including lower voltage THD and current THD. A course-connected H connect inverter generates a ventured ac voltage waveform. Because the voltage yield of the multilayer inverter is a single wave that closely mimics a perfectly sinusoidal ac voltage, the necessity for channels is reduced. Furthermore, the cost and size of the overall framework are lowered as a result of the reduced channel needs. Because each stage of a multilevel inverter has a connected dc source, this innovation is appealing for the use of solar-oriented photovoltaic boards, which also generate power in stages. This project employs MATLAB Simulink to design a 27-level inverter. The entire consonant mutilation in the outcomes confirms the plan's validity. [3]

2. MULTILEVEL INVERTER

Initially, the inverters were used to power the majority of the supporting stack when the framework took off. However, due to increased advancement in invention, inverters are expanding their range of uses. Previously, a two-level inverter was used to create the yield with two unique voltage levels, but it has high exchanging losses and consonant voltage induces the flow of the consonant current within the circuit and produces the losses. So, to overcome the impediments, certain advancements are made in the existing inverter such that levels can be expanded more than two so that an unadulterated sinusoidal waveform is delivered at the output voltage and sounds within the yield can be muffled and the rate of misfortunes can be decreased.

There are mainly three different types of the multilevel inverter

1) Diode clamped multilevel inverter
2) Flying capacitor multilevel inverter
3) Cascaded H- bridge inverter

Over the two level inverter, these multilevel inverters have a few focal points.

1) Reduced distortion's impact on consonance.
2) Due to the numerous voltage levels, the sine waveform is flawless.
3) Performs important and lofty exchanging recurrence. PWM
4) Reduced exchanging misfortunes
5) Excellent control quality
6) Low rate of voltage change

Unfortunately, multilayer inverters have a few drawbacks. One major downside of these is that despite their lower rating, they require a large number of switches. Because each switch is linked to its own door driving circuit, the overall framework becomes more complex and expensive.

3. CONCEPT OF MULTILEVEL INVERTER

A typical two-level inverter generates two levels within the yield voltage. Despite the fact that the AC yield waveform is provided, it contains noises, which produces a higher rate of voltage change than a multilayer inverter. A few devices necessitate a slow rate of voltage change.

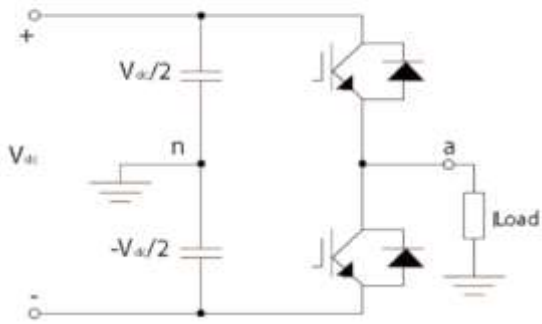

Figure 1-Two level inverter

In a multilayer inverter, we generate more than two voltage levels that exhibit a nearly sinusoidal yield voltage wave-form. Because of the various voltage levels inside the yield, the waveform becomes smoother, but as the levels increase, the circuit becomes more complex owing to the expansion of the valves. In addition, a complex control circuit is necessary.

3.1 Comparison between conventional and multilevel inverter

S.no	**Conventional inverter**	**Multilevel inverter**
1.	Increased THD in yield voltage	Reduced THD in yield voltage
2.	High switching stresses exist in the device.	The switching strains on the device are low.
3.	Not suitable for high-voltage applications.	Suitable for high-voltage applications
4.	Inability to generate high voltage levels	Can generate high voltage levels
5.	Switching losses are significant.	Switching losses are minimal.

4. DIFFERENT TOPOLOGIES OF MULTILEVEL INVERTER.

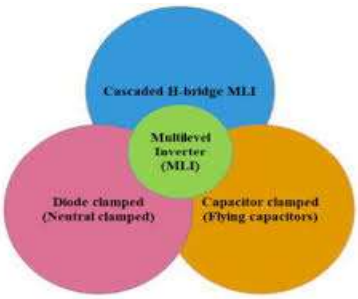

Figure-2 Topologies of multilevel inverter

There are essentially three sorts of multilevel inverter classified agreeing to the voltage source utilized within the inverter. The Fig.2 underneath appears the topologies of multilevel inverter

4.1 Diode Clamped Multilevel Inverter

It was developed in 1981 and is also known as a neutral point clamped inverter (NPC). The DCMLI topology, which is utilised to produce an output voltage with three levels, is shown in Figure 3. Four unidirectional power switches, two diodes, and two capacitors make up this topology's configuration. To distribute the blocking voltage among the clamping diodes, they are wired in series.

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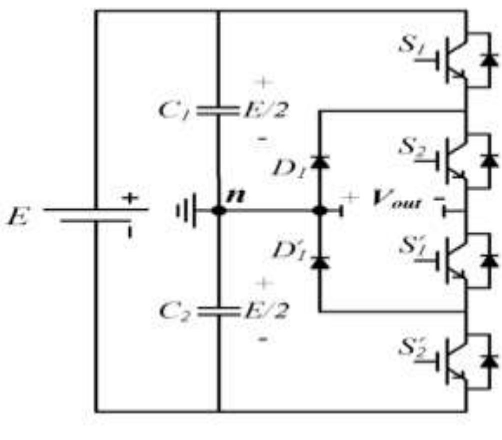

Figure 3- Diode Clamped Multilevel Inverter

The output voltage in this architecture has three levels: Vdc/2, 0, and Vdc/2. Vdc/2 is produced by leaving S1 and S2 switches on, while Vdc/2 is produced by turning on S3 and S4. The 0 level voltage is created by turning on switches S2 and S3. It is anticipated that each active switching device will experience voltage stress throughout the passage of the equivalent voltage across the DC link capacitors, with this voltage stress being clamped to the voltage of each capacitor using diode clamping. In a practical application, the clamping diodes are connected in series to share the blocking voltage. Then, each active device merely needs to block a voltage level of V /(m 1) dc. The clamping diodes' voltage ratings must differ for reverse voltage blocking. The primary problem with the design in high voltage applications, when using the DCMLI under PWM, is the clamping diodes' diode reverse recovery. Due to its high-power delivery capability, simplicity, and efficiency, the DCMLI has a greater industrial use than the other multilevel converter topologies. It has found use in variable speed motor drives, high voltage system interconnections, and static VAR compensators (SVC). The DCMLI converter does not require a capacitor because all of its parts are connected via a single DC bus. As a result, it can be applied to different back-to-back topologies, such as adjustable speed drives and high voltage back-to-back connectivity. However, the issues with this converter include the challenge of balancing and stabilising the capacitor DC voltage in the DC link, as well as the difficulty in real power flow from a single inverter owing to discharging or overcharging of the DC level without proper control.

4.2 Flying Capacitor Multilevel Inverter

The topologies of the FCMLI and DCMLI are very similar; the difference is that the FCMLI uses floating capacitors rather than clamping diodes. The size of the voltage steps in the output waveform of the FCMLI is a direct result of the voltage variation in the nearby capacitors. The'm' level inverter's FCMLI structure consists of 0m 1 0 DC link capacitors. Figure 4 shows a schematic of the three-level FCMLI topology, which also includes a DC supply with two capacitors to acquire the voltage levels (Vdc/2, 0, and Vdc/2) and four unidirectional power switches and a flying capacitor. For the positive polarity output voltage to be produced, switches S1 and S2 must be in the ON position, while while S3 and S4 are switched ON for the negative polarity output voltage. Switches S1 and S3 or S2 and S4 are activated to produce the output voltage at the 0 level. Compared to a DCMLI, the voltage synthesis in the FCMLI is more adaptable. By carefully choosing the switching combination, the issue of voltage balancing can be solved when there are more than five levels. The ability to manage the reactive and active power is one of this topology's main advantages. On the other hand, the usage of several capacitors makes the system expensive and challenging to assemble. Furthermore, real power transmission in such setups suffers from large switching frequency losses.

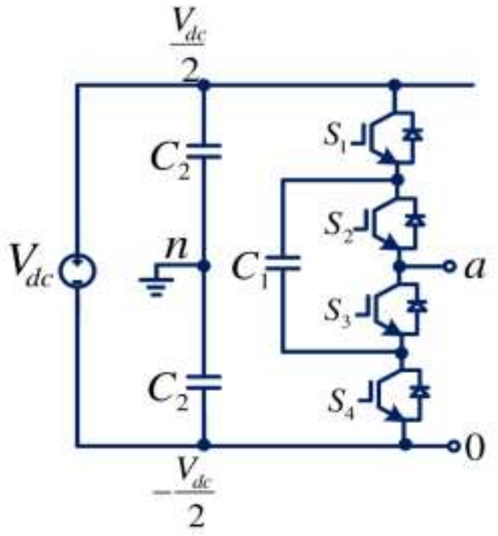

Figure 4- Flying Capacitor Multilevel Inverter

4.3 Cascaded H-Bridge Inverter

The serial connecting of several single-phase H-bridge inverters with independent DC sources results in the creation of CHB-MLIs (SDCS). Figure 3 depicts an H-bridge with four unidirectional power switches and one DC supply. The four switches (S1-S4) are connected in various ways to generate the desired output. Each inverter level is programmed to provide three voltage outputs (+Vdc, 0, and Vdc) via the connection of the DC source to the AC output. The +Vdc output is created when the S1 and S4 switches are in the ON position, whereas the Vdc output is produced when the S2 and S3 switches are in the ON position. Either S1 and S2 or S3 and S4 must be in the ON state in order to generate the 0 output voltage. The full-bridge inverter's AC outputs are connected in series such that the voltage waveform created represents the total of the outputs from all the inverters. The number of output phase voltage levels in a cascade inverter is denoted by $m = 2s + 1$, where s is the variety of DC sources. Compared to DCMLI and FCMLI, this design requires fewer components because clamping diodes and clamping capacitors are not used. Additionally, because it lacks DC link capacitors, it is free of the voltage balancing issue. Conversely, independent renewable energy sources and separate converters can be used to replace the various DC sources, or by single renewable energy sources with multioutput converters where the voltage balancing is the major concern. Multilevel cascaded inverters have been proposed for use in applications for the generation of static variables, as well as an interface with RES; they have also been considered for use in battery-powered applications. A cascade inverter can be directly connected in series with the electrical system and utilised for static var correction as well. As they require independent DC sources when utilised in fuel cells and photovoltaics, they are appropriate for connecting RES to the AC grid. They have also been suggested for usage as the primary traction drive in electric vehicles because several batteries or ultracapacitors work as SDCSs in these applications. This topology's structure is adaptable and can be employed with various numbers of inverter levels. By applying varying ratios of DC sources and minimising switching redundancy caused by inner voltage levels, different output voltages can be generated. To lessen the requirement for independent DC sources, transformer-dependent CHBMLIs have been created; they have a CHBMLI-like structure but are distinguished by the serial connection of the output voltage of the isolation transformer.[2]Here, the proposed study outlines the design and application of a novel multilevel inverter method for a solar-powered board. Most often, two level cascade inverters are used for voltage conversion from DC to AC. In this study, a two-level inverter was able to provide two distinct voltage levels or yields. The yield voltage waveform is roughly in the shape of two levels, therefore the THD of a 2-level inverter isn't as high, or unusually high. To limit and lower the THD value, an underused multilayer inverter is shown here with fewer switches. Different levels of DC voltage sources are used to synthesize the desired AC voltage.[3]

Two different types of multi level inverters were modelled and implemented in hardware in this study. According to the results of the simulation, the proposed topology 2's THD Range has a consonant mutilation spectrum of 5.51%.

The proposed architecture 1 includes actualized multi carrier stage relocated PWM as well. The most hard scenario is the voltage adjustment problems at the source and stack sides. By utilising a hysteresis controller within the proposed topology, the capacitor voltage adjusting technique is developed based on third consonant balanced infusion1. The model that was additionally produced for both the planned and actual results was also authorized. [4]

The use of a seven-level cascade H-bridge MLI for a grid-connected PV framework based on a Phase Shift Pulse Width Modulation (PSPWM) method was demonstrated in this paper. The system was successful in providing a compelling interface between the network and divided sun based boards as DC sources by controlling the battery execution based on MPPT and an advanced control technique.

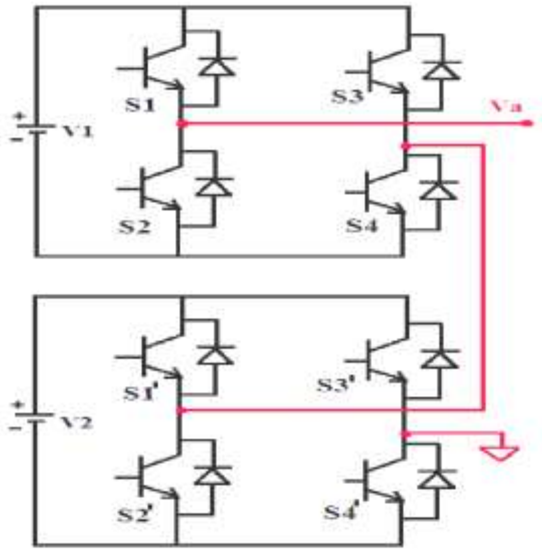

Figure 5 Cascaded H-Bridge Inverter

The proportionate demonstration includes three boards associated in arrangement to constitute the actualized PV/battery framework coordinates with the H-bridge MLI. By regulating battery performance, the DC transmission voltage is kept stable in the face of various disruptive factors. Additionally, compared to a standard inverter, the cascade H-bridge MLI execution appears to significantly reduce noise. This makes the Inverter capable of eliminating a tall sum of consonant, with moo THD voltage.[5]

This study investigates the operation of a PV system with a boost converter, where the MPPT method and a multi-level inverter topology control the exchange. Due to its ability to provide waveforms with a far wider consonant range, multilevel inverters are suitable for use in high voltage and high control applications. This study first discusses the design and consideration of the P-V and I-V characteristics of the PV framework, after which the yield is related to the boost converter. MPPT calculation with P and O sort is used for exchanging. Finally, this previous structure is connected to a cascaded multilevel inverter based on multiple carriers. The elemental yield voltage is improved by the cascaded multilevel inverter technique, which also reduces consonant mutilation. To answer the question, a single stage, five level cascaded inverter is used. Effectively, the ponder can be stretched to an m-level inverter. Consonant examination, measured THD, and yield voltages are contrasted and analysed with a DC-AC inverter in an effort to validate the framework's main elements.[6]

When compared to other conventional topologies, the inverter in the suggested figure contains less switches. The switch diminishment causes a decrease in the starting amount fetched. From the reproduction, the THD value is determined, and it is compared to the THD value of a multilayer inverter with values from more recent times and after level sifting. This results in a decrease in THD value when using the Specific Consonant End Beat Width Tweak Strategy. Here, THD is reduced by using closed-circle PWM techniques. Utilizing LCL filtering condition will reduce it initially as you learn a sounds period.

5. MODELING OF 27 LEVEL MULTILEVEL INVERTER

Each block of the cascade multilevel inverter has its own voltage source. By mixing the switches, 27 unique voltage levels can be formed. Figure 6 displays the internal circuit of the first block.

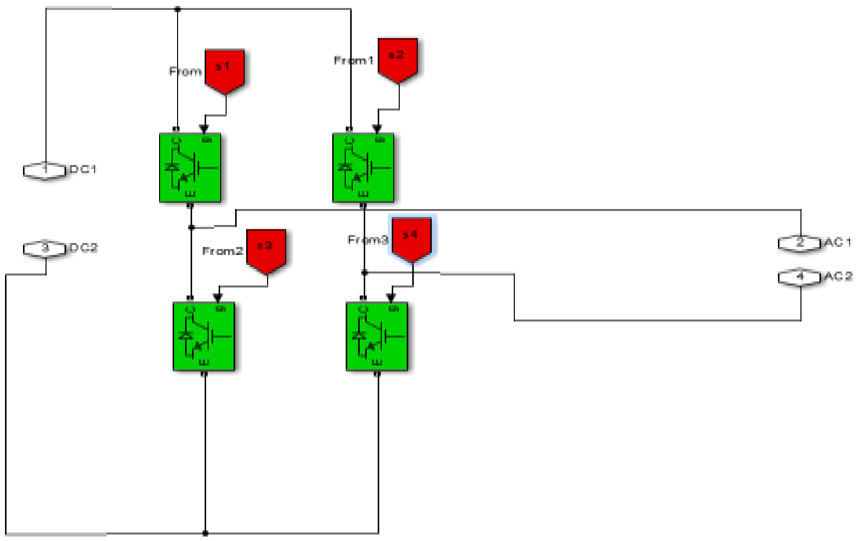

Figure-6 Simulation Model of Each Block.

When S1 and S4 switches are turned on, the first block's output is Vdc; when S2 and S3 switches are turned on, it is -Vdc; and when S2 and S4 switches are turned on, it is 0 volt. The second and third blocks, like the first, can generate three voltages by combining different switches. From the three voltage combinations of each block, a total of 33 = 27 voltages may be derived at the output stage, and with the proper sequencing, the output voltage will be a stepped voltage with a form comparable to the desired sinusoidal voltage. Figure 7 depicts the outcomes of the whole simulation, which was run in MATLAB Simulink.

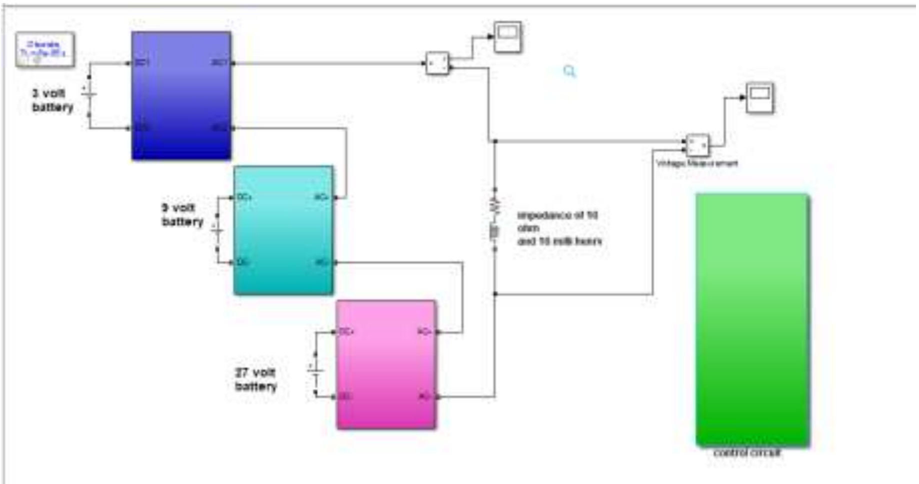

Figure 7 Simulation Model of a 27 Level Inverter

The model reveals that it is made up of a series of three-stage inverters. The first stage of the inverter is powered by a 3 volt source, the second stage by a 9 volt source, and the third stage by a 27 volt source. The inverter's output is linked to a load with a resistance of 10 ohms and an inductance of 10 milli henrys. The solar panels' output is thought to be a constant dc source, and each solar panel is thought to be connected to a separate panel with outputs of 3, 9, and 27 volts. These dc voltages must be turned into an alternating current source in order to power the ac load.

5.1 SWITCHING TECHNIQUE OF THE PROPOSED MODEL

Table 2 Switching Table of the Model

Output voltage	**s1**	**s2**	**s3**	**s4**	**s5**	**s6**	**s7**	**s8**	**s9**	**s10**	**s11**	**s12**
-39	0	1	1	0	0	1	1	0	0	1	1	0
-36	0	0	1	1	0	1	1	0	0	1	1	0
-33	1	0	0	1	0	1	1	0	0	1	1	0
-30	0	1	1	0	0	0	1	1	0	1	1	0
-27	0	0	1	1	0	0	1	1	0	1	1	0
-24	1	0	0	1	0	0	1	1	0	1	1	0
-21	0	1	1	0	1	0	0	1	0	1	1	0
-18	0	0	1	1	1	0	0	1	0	1	1	0
-15	1	0	0	1	1	0	0	1	0	1	1	0
-12	0	1	1	0	0	1	1	0	0	0	1	1
-9	0	0	1	1	0	1	1	0	0	0	1	1
-6	1	0	0	1	0	1	1	0	0	0	1	1
-3	0	1	1	0	0	0	1	1	0	0	1	1
0	0	0	1	1	0	0	1	1	0	0	1	1
3	1	0	0	1	0	0	1	1	0	0	1	1
6	0	1	1	0	1	0	0	1	0	0	1	1
9	0	0	1	1	1	0	0	1	0	0	1	1
12	1	0	0	1	1	0	0	1	0	0	1	1
15	0	1	1	0	0	1	1	0	1	0	0	1
18	0	0	1	1	0	1	1	0	1	0	0	1
21	1	0	0	1	0	1	1	0	1	0	0	1
24	0	1	1	0	0	0	1	1	1	0	0	1
27	0	0	1	1	0	0	1	1	1	0	0	1
30	1	0	0	1	0	0	1	1	1	0	0	1
33	0	1	1	0	1	0	0	1	1	0	0	1
36	0	0	1	1	1	0	0	1	1	0	0	1
39	1	0	0	1	1	0	0	1	1	0	0	1

A variety of output values can be obtained by combining various switches on the ac side. The ac output voltages contain a 3 volt step between -39 and 39 volts. Table 1 shows the switching table for variable voltage output on the alternating current side.

Let's use the example of receiving 39 volts at the output to show the table. The three positive voltages must be put together to equal 39 volts (3+9+27). This is accomplished by activating switches s1 and s4 in the first step, s5 and s8 in the second stage, and s9 and s12 in the third stage. This pattern is followed by this switching pattern.

5.2 CONTROL TECHNIQUE OF THE PROPOSED MODEL

The inverter is managed utilizing a discrete control method to give an output voltage with the lowest possible total harmonic distortion. A reference voltage with a frequency of 50 Hz and an amplitude of 39 volts is used. After further dividing the reference voltage into discrete voltage ranges in steps of three, 27 unique voltages are obtained. For example, when the discrete reference voltage value is -33, -24, -15, -6, 3, 12, 21, 30, or 39, the first stage's switch s1 is triggered. Switching signals are generated based on the necessary combination of these distinct voltages. As a result, the switch S1 is properly switched. Similarly, all of the switches' switching signals are generated in line with Table 2 Scheme.

6. RESULT

Figure 8 depicts the proposed model's outpul voltage.

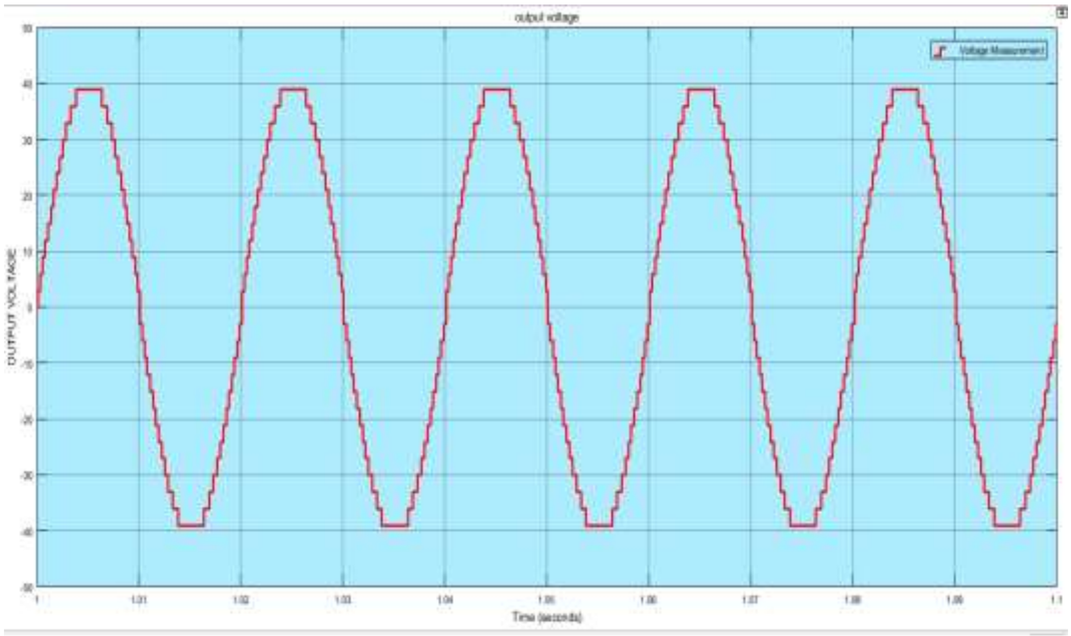

Figure 8 Output Voltage Waveform

As observed in the graphic, the output voltage looks to be extremely near to the sinusoidal voltage of magnitude 39 volts. Figure 9 depicts the output current waveform of the suggested model created in MATLAB Simulink.

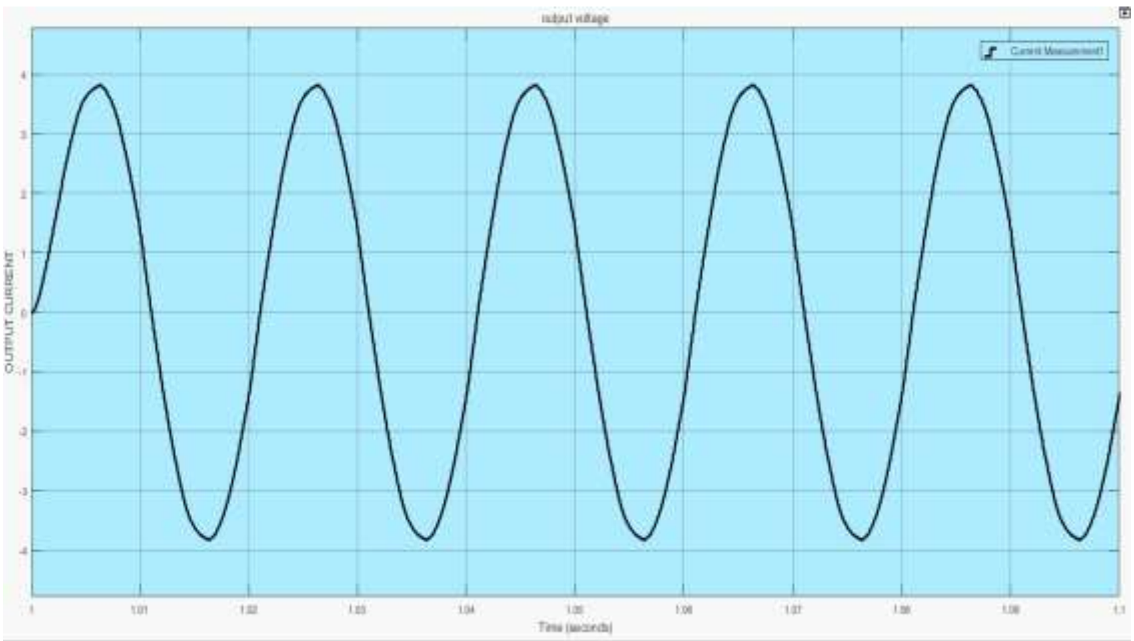

Figure 9 Output Current Waveform

The current waveform is almost harmonic-free, as can be seen.

FFT analysis of voltage and current waveforms is also performed in MATLAB Simulink. Figures 10 and 11 show the FFT analysis's output voltage and current.

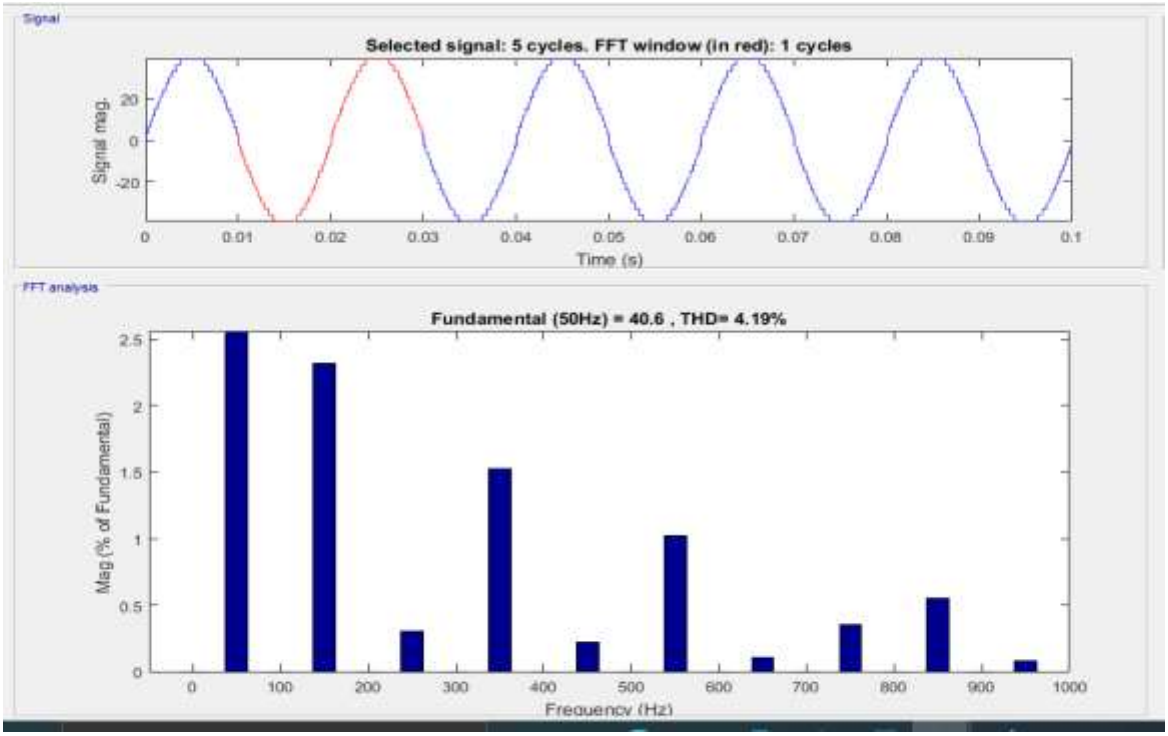

Figure 10 Analysis of FFT Showing Output Voltage

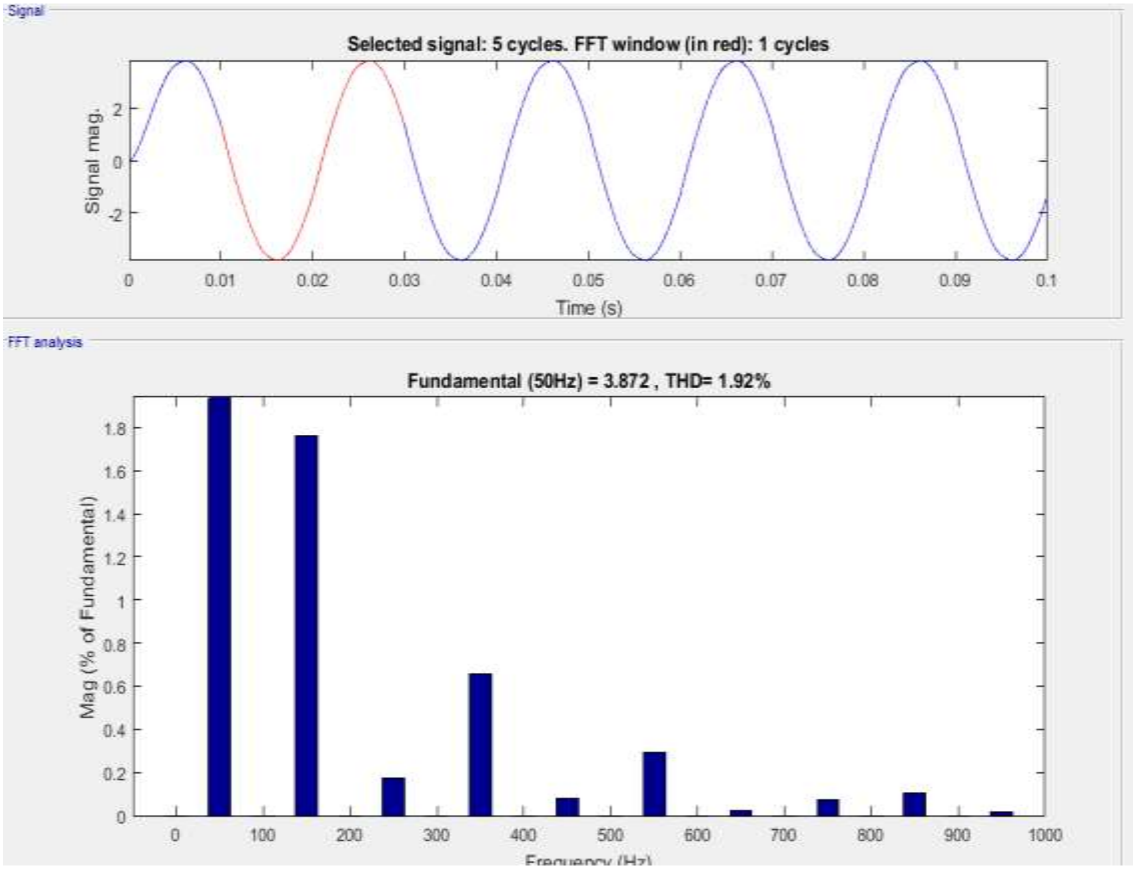

Figure 11 Analysis of FFT Showing Output Current

7. CONCLUSIONS

The inverter is managed utilising a discrete control method to give an output voltage with the lowest possible total harmonic distortion. A reference voltage with a frequency of 50 Hz and an amplitude of 39 volts is used. After further dividing the reference voltage into discrete voltage ranges in steps of three, 27 unique voltages are obtained. For example, when the discrete reference voltage value is -33, -24, -15, -6, 3, 12, 21, 30, or 39, the first stage's switch s1 is triggered. Switching signals are generated based on the necessary combination of these distinct voltages. As a result, the switch S1 is properly switched. As in the production of switching signals for each switch,shown in table 2

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