International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

9 LEVEL ML INVERTER WITH SPWM TECHNIQUE FOR REDUCED NUMBER OF SWITCHES

RACHAMALLA SARADA[1], V BRAMHAIAH[2]

[1]M.Tech Scholar, [2]Assistant Professor
Department Of Electrical and Electronics Engineering
Tadipatri Engineering College, Tadipatri.

Abstract:
Currently, building-scale inverters (MLI) are an increasing number of used for medium-voltage and power programs due to their many blessings, such as low-voltage transmission via equipment switches. This design proposes a switched energy capacitor based on a single-thing 9-level strength converter. The strength of the five-section converter locations a heavy load on the electricity converter rod. By growing the signal stage within the electricity converter circuit, distortion and voltage will be reduced, and this could be finished through running a multi-level inverter. Multi-level inverters (MLI) are designed the usage of one or extra sources. Higher-degree MLIs require extra elements. Improvements in multi-level inverters encompass the development of many degree topologies with fewer components and higher performance. A 9-level switch-mode strength converter device is used to transform DC to AC and deliver the RL load. This technique reduces the entire harmonic distortion compared to different strategies. The system turned into advanced and examined the use of Mat lab simulation software and hardware.

Keywords: Multi-level Inverting (MLI); software and hardware, Mat lab simulation.

INTRODUCTION

Historically, large inverters have met the increasing demands of high-power business packages, which now range from tens to numerous megawatts. An instance of this is square-scale AC cars operated inside the medium voltage range (2.3 to 13.8 kV). Currently, the problem of connecting a single semiconductor power switch to the grid is because of the high voltage limit. To clear up this hassle, a plug-in kind strength converter answer turned into added for high-energy applications. Structural modifications use high-velocity switching elements, connecting between more than one DC stages, avoiding the problem of connecting man or woman gadgets to the grid. Square wave converter systems are discovered in a spread of packages; Industrial motor drives, renewable energy structures (photovoltaics, wind and gasoline cells), complete-featured modern-day transmission systems (FACTS), excessive voltage direct modern-day (HVDC), transmission systems and traction drives. Many topological structures had been developed inside the last few years. They are square they are tons more advanced in modulation than the vintage 2-phase converters due to the fact they have to undergo many modifications. Over the final 3 many years, many topological converter topologies were developed. Furthermore, many modulation techniques have emerged from these changes. Modulation methods encompass SPWM, SHE-PWM, and SVM. The latest and most famous topology for strength applications is the Mesh to Cell (M2C) converter. Various manage and modulation strategies were encouraged for this topology. The intention of this grasp's thesis undertaking is to very well inspect and evaluate certainly one of them, that's supported by means of a pulse width modulation (PWM) segment shifter. In this paintings, four absolutely special topologies had been investigated and investigated to put in force the PWM mode of element change within the general square wave shape of the manage system. This topology will have 3 control loops: the common manage maintains the current inside the converter, the individual control maintains the stability of the present day and capacitor voltage, and the leg stability control continues the voltage distinction among the legs of the converter. In addition, those topologies are smooth to enforce and do not require a couple of processing steps. This layout gives a

switching frequency so that it will meet two essential standards: low sufficient to keep price efficiency, and high enough to gain harmonic overall performance goals. This work additionally proposes an analytical expression for the relative strength of the converter's output voltage spectrum, which helps expect harmonic overall performance.

A multi-stage electricity converter may be a energy device that is designed to simply accept a preferred AC voltage from multiple DC voltage tiers. Multi-degree inverters were an essential development in current years, as they can extend the voltage and strength supplied to the motor using currently used semiconductors. Inverters have added layout functions to high-strength programs due to the fact they provide numerous benefits. Instead of the usage of electric machines and dynamic voltage equalization circuits, they realise high voltage and high power output through fault-tolerant semiconductor switches. As the range of output levels increases, output voltage and contemporary harmonics and electromagnetic interference (EMI) will decrease. The simple concept of a structural electricity converter is to achieve high strength via the use of a series of semiconductor diodes with more than one low-voltage DC sources to convert energy thru synchronization inside the shape of voltage waveforms. In order to obtain an almost linear curve of output voltage distortion, it is vital to generate an excitation sign to manipulate the switching frequency of each power semiconductor. In this paper, the excitation signals of the multi-stage wave converter are described by using reflecting the PWM curve version. In this paper, a completely unique electricity converter structure is designed and carried out. The essential characteristic of the topology is that the additives are designed to minimize the strength. The motive of the topology structure is to reduce the voltage rating of the switched strength. Therefore, it's far usually used whilst superb quality is used. By combining voltages structurally, its benefits are low dv/dt, low input cutting-edge dissipation, and occasional switching frequency. Due to the benefits of structural topology, many topologies have emerged in current years. The extra powerful the application, the greater effective the tool specifications will be.

Although the IGBT has a higher electricity rating and better voltage variety, it can't function at better frequencies. Sometimes a ligature is likewise required for the gate. The MOSFET is a high-frequency component, however the electricity score of the IGBT is not good. To resolve this hassle, many opportunity structural topologies are evaluated with a lower thing, while a extra powerful issue is used.

RELATED WORK

Asymmetric Nine-Stage Inverter Circuit Using Power Kouro S et al., (2010) supplied a short review of properly-set up structural modifications primarily based on the cutting-edge country of the art in business programs, after which discussed new adjustments that have set up their presence within the marketplace. In addition, promising new topologies had been identified. They are together attributed to recent advances in the modulation and manipulate of structural changes. A huge a part of this newsletter is dedicated to showing the applications of structural additives and the way structural components were diagnosed in many areas of industrial technology. Finally, a few destiny tendencies and challenges in any improvement of this technology are identified, thereby encouraging future contributions in order to cope with open questions and explore new perspectives [1].

Bronisław Malinowski M et al., (2010) reviewed the diverse topologies, manage techniques, and modulation strategies utilized by cascaded inverter architectures. In the regenerative version, cascade inverter configurations have moved from theoretical design to real-global packages due to many excellent features which include excessive modularity, opportunity of connection to medium voltage, excessive power exceptional, character inputs and outputs, ready-made competencies and consequently manage strength. Regenerative and extended topologies are mentioned together. Applications in which particular alternatives play a greater position are shown within the blocks. Finally, future trends are directed towards them [2].

Fariwar G. Et al. (2016) designed a cascaded H-bridge (CHB) material gadget based on a photovoltaic (PV) gadget without voltage or modern sensors at the DC side. The biggest benefit of disposing of the DC facet of the sensors is the easier hardware, which ends up in decrease prices and stepped forward reliability of the PV device. The most effective issue discussed is that the capacitor voltage is calculated on the output AC voltage of the energy converter. This logic allows you to update all DC aspect voltage detectors with a single AC side voltage detector from the manufacturer. In addition, for DC sensors, the transformer is needed to absolutely dispose of the maximum strength factor monitoring (MPPT). Instead, the output from the capacitor voltage ratio is used for MPPT. In the destiny, to improve the robustness of the system, the implementation of the deliberate system within the event of a switching tool failure become thoroughly studied [3].

Chavarria J. Et al. (2013) proposed a electricity balance management method for a unmarried-segment grid-tied converter with an H-bridge shape, that's coupled to an unbiased photovoltaic (PV) array for grid-tied power. The strength manipulate idea is based totally on the information version of the photovoltaic gadget and lets in the advent of a line voltage loop for each regulator, which lets in for device reliability over the entire range of PV operating conditions. The control scheme is well suited with phase-shifted and phase-shifted pulse modulation, to concurrently adjust the waveform and preserve each photovoltaic array at its maximum strength, whilst distributing the manage paintings among the grid bridges. In the case of PS-PWM, an FPGA-based totally layout running at a low switching frequency could be taken into consideration to reduce switching losses, but, if LS-PWM is adopted it will be a more stringent choice, because the minimal switching frequency is decided by both the significance/phase frequency and the manage solution supported by way of the FPGA platform [4].

Coppola M. Et al. (2016) designed a complicated manipulate design for an H-bridge (CHB) converter with a grid-linked grid system. The circuit topology includes traditional energy cells (H-bridge configuration) related in collection and ready with character PV modules. The control technique adopted is a hybrid PWM strategy, which uses a programmable set of rules to hold the switching kingdom of the cells. Cell popularity shows the want to fee or discharge one cellular before the others, considering the voltage mistakes (for instance, the distinction among the MPPT reference value and the measured price) on every DC hyperlink. Efficient MPPT P&O permits each DC hyperlink voltage to be controlled independently, maximizing electricity extraction even in severe conditions. The control phase is applied in an FPGA using the d-SPAculum real-time hardware platform, which "permits for fully dedicated digital circuitry" [5].

EXISTING SYSTEM

The design of the converter is by no means one of many layout configurations. It is fashioned via connecting a single-phase H-bridge converter in a non-parallel way, as in Figure 3.1, with every converter generating a square voltage wave with a very specific cycle, as inside the figure. But this text will spotlight the first harmonic version, now not the high-frequency PWM variant.

Battery Voltage. Gift fuel cells normally produce a DC voltage of 30V to 50V at full load. When one of these gas cells is connected to a mixed AC strength converter, it will not be to be had for the AC grid voltage output of the film. To growth the voltage stage of the power converter, a DC-DC step-down converter is generally required. This step-down converter, further to increasing the cellular power voltage, additionally regulates the input voltage of the strength converter and separates the low and excessive voltage levels. A energy inverter for domestic use is either single section or dual phase. Residential packages, consisting of hospitals, colleges, condominium homes, and so on.Haveaneveryday load profile wherein complete load is constantly on and coffee load is usually off. The consumption can be calculated underneath complete load conditions; but, at some point of low-load operation, due to the burden-dependent traits of gas cells, the cell voltage may be as low as 5 hundredths of complete load. This voltage increase calls for

voltage reduction via the strength converter gadgets. The DC-DC improve converter keeps a stable DC connection, so it isn't always important to noticeably lessen the voltage of the energy converter; But the DC-DC converter nonetheless wishes to be derated. This will also increase the value, even though it will no longer be in particular useful because the price boom will not be big in this application. The great solution is to apply the periodic method mentioned within the DC to DC converter application to energy a three-phase converter. The degree reduction is carried out with the aid of the cells failing individually because the load contemporary decreases. The voltage is decreased through the converter rods, which maintains the voltage and energy required for the converter and the burden. The derating machine is designed for applications in residential homes, schools, hospitals, and so forth. This load adjustments at some stage in the day. But the modifications in load are commonly now not rapid; therefore, the high frequency changes of the DC to DC converter aren't a problem. Since this converter modifications the DC voltage level when needed, it's far very clean to control the converter. To growth the energy and efficiency of fuel cells, price carriers may be compressed the usage of H-bridges and focal cells. Furthermore, because the working time of an electric mobile is commonly laid out in running hours, the operating time of an electric powered cell also can be elevated by suppressing the compressed focal cells. Since an immediate comparison of sine and triangle is used rather than optimizing the switching mode, the overall harmonic distortion (THD) may be prioritized.

PROPOSED SYSTEM

This design proposes a switched power capacitor based totally on a nine-country single-phase electricity converter. The -level energy conversion places a heavy load at the electricity converter rod. By increasing the strength element in the converter circuit, it is feasible to reduce distortion and voltage, and that is performed by using working a multi-state inverter. Multi-degree inverters (MLI) are designed with one or greater assets. High-level MLIs are anticipated to play multiple roles. Improvements in multi-level inverters consist of the improvement of multi-level topologies with fewer additives and improved level designs. A nine-stage structure of six switching power converters is designed to convert DC to AC and offer one RL. This technique has decrease ordinary distortion in comparison to traditional techniques. The voltage magnitude is split with the aid of 3 0.5 via the movement of the three DC capacitances. A tremendous cycle of zero.5 and a terrible cycle of 0.Five are acquired using a full bridge circuit; this results in Vdc and 3Vdc auxiliary circuit tiers. Due to the excessive strength converter topology, handiest 2 contemporary rods are transported for each technology level. The designed system reduced the quantity of pressure circuits, provided a strong shape, improved power best, and progressed electricity efficiency. Figure three.2 suggests the designed electricity conversion shape of a seven-level converter. The designed configuration is very useful for person applications. The seven-degree electricity converter will have a fixed configuration, and the steps may be prolonged to govern the DC hyperlink voltage with extra auxiliary circuits. The distinctive operation for each half is as follows:

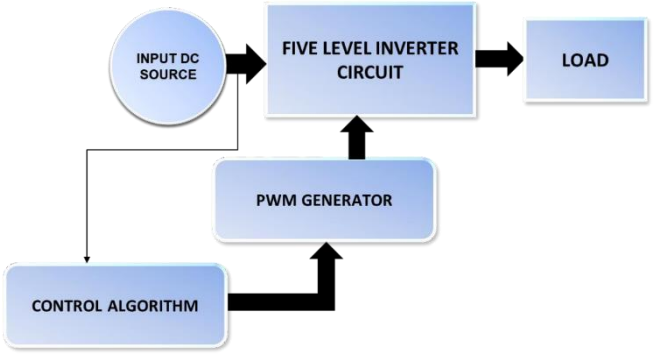


Fig 1: design of the projected topology

SEVEN LEVEL ELECTRICAL CONVERTER

Many level inverters have shown a fantastic performance this time. In multi-degree inverters, the better the level, the less distortion in the signal, the lower the voltage throughout the transfer. Multi-degree inverters

(MLI) are designed with one or more sources. High-degree MLIs are anticipated to play a couple of roles. Improvements in multi-level inverters consist of the improvement of multi-stage topologies with fewer additives and stepped forward level designs. Figure three shows the topology of a nine-step, six-transfer multi-stage electricity converter that converts a DC enter into a nine-step signal. This topology has 2 assets and 6 switches. Table 1 shows the segment shift of a 9-stage six-switch converter.

Level of Voltage	S1	S2	S3	S4	S5	S6
Vdc	1	1	0	0	0	0
2Vdc/3	0	1	0	0	1	0
Vdc/3	0	1	0	0	0	1
0	0	1	0	1	0	0
- Vdc/3	0	0	1	0	1	0
-2Vdc/3	0	0	1	0	0	1
-Vdc	0	0	1	1	0	0

Table 1: The switching states of 9-level six switch inverter.

CIRCUIT CONFIGURATION

This inverter includes four switches S1, S3, S3, S4, and 4 diodes D1, D3, D3, and D4. Two capacitors C1 and C3 act as a voltage divider. The auxiliary transfer, including a bidirectional switch S5 and four diodes D5, D6, D9, and D8, is attached between terminal A and the tremendous load terminal.

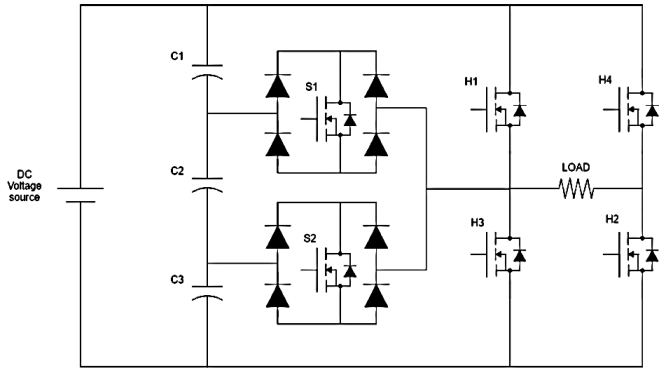


Fig 2: Circuit diagram of the proposed 9 level inverter

CONTROL ALGORITHM

As shown in Figure 4, easy pulse width modulation without enhance pulse method is used to generate the 5-level control sign. The high frequency service is as compared to a phase modulated waveform to generate the switching signal for switches S1 - S5. It may be visible that the switching pulses S3 and S4 function on the input and main switching frequencies; the alternative rods operate at higher switching frequencies. The modulation code determines the output voltage degree. It should be saved within the visible range of 0 to at least one for the linear manage voltage output. Ma > 1 causes excessive modulation, resulting in an excessive harmonic in the output segment voltage.

RESULTS AND DISCUSSION

The proposed topology has been proven the usage of Matlab simulation and a prototype model has been tested. The simulated evolution of the enter voltage, DC capacitor voltage, output voltage of the seven-level inverter and the corresponding load modern. The voltage throughout the capacitors is stored at 150V to supply a seven-step output voltage waveform. It may be visible that the output voltage remains steady during load modifications. Using a appropriate controller, the output voltage may be adjusted with the weight step change and the trade in enter voltage. The five-degree inversion suggests the measured frequency spectrum of each the output voltage and cargo contemporary waveforms. The %THD of the output modern-day is inside the IEEE standard.

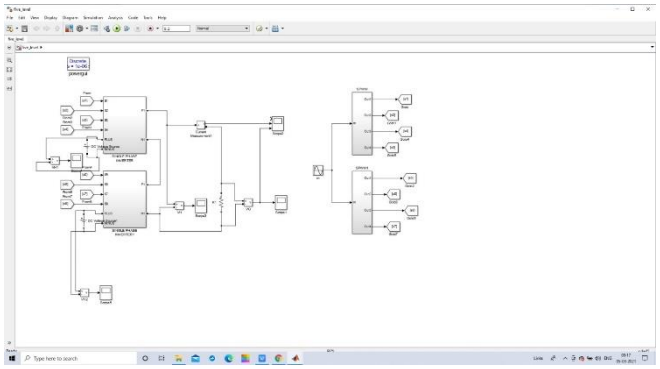


Fig 4: Circuit diagram of 5 level simulation-existing system.

INPUT DC VOLTAGE SOURCE ACROSS 1 PHASE INVERTER

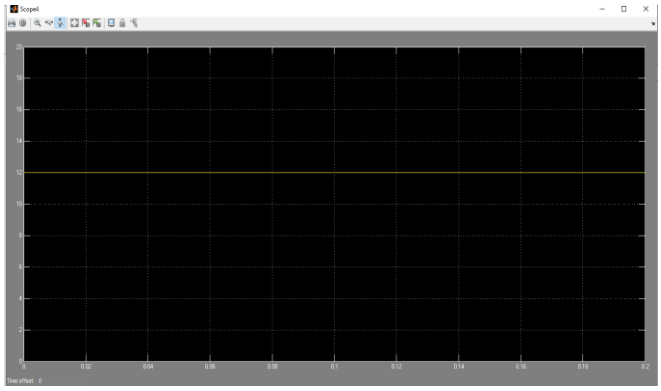


Fig 4: Input dc voltage source across single phase inverter

The above figure 4 shows Input voltage of 12V using mat lab simulation.

INPUT DC VOLTAGE SOURCE ACROSS 1 PHASE INVERTER 1

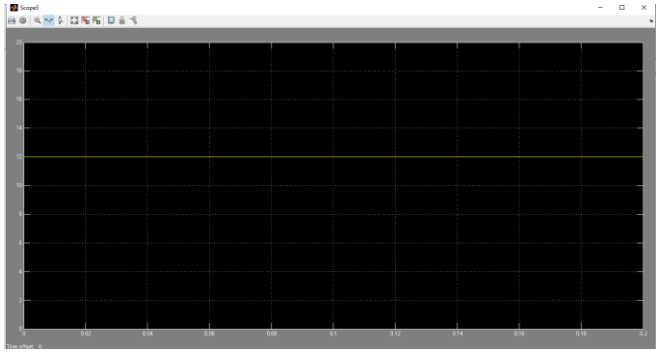


Fig 5: Input dc voltage source across single phase inverter 1

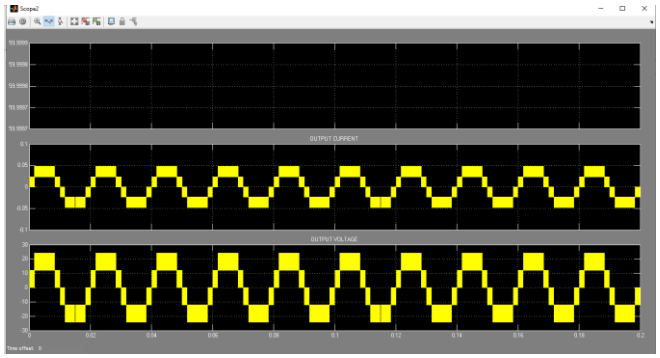


Fig 6:Current and voltage output

The above figure 5 Scope is connected across output voltage and current. We take to the output of 24V.
OUTPUT VOLTAGEOUTPUT VOLTAGE = 24V

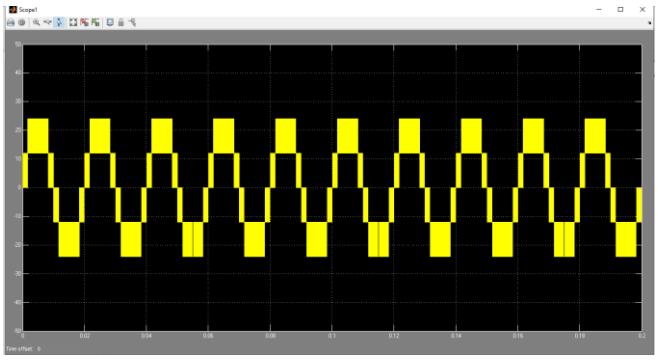


Fig 7: Output voltage

The above figure 6 shows Output voltage is taken 24V, Scope is connected across output voltage.
5 LEVEL THD
TOTAL HARMONIC DISTORTION(THD) = 26.99%

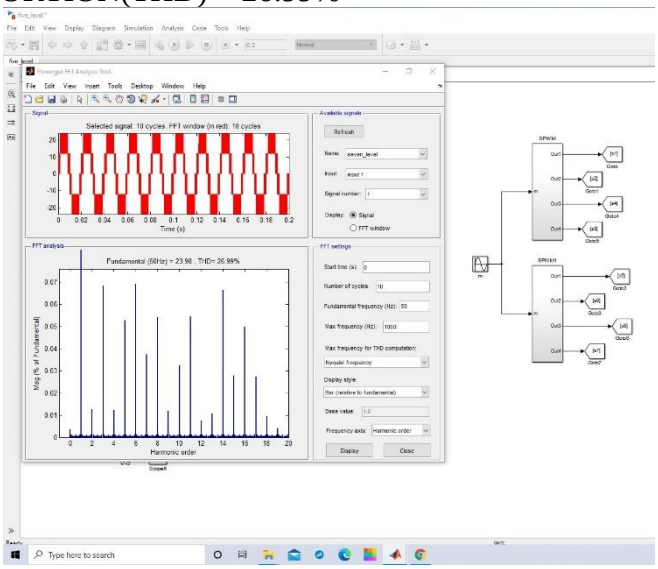


Fig 8: Total harmonic distortion of 5 level

The above figure 8we are taken to the Total Harmonic Distortion. That was 26.99% for 5 level simulation.
PROPOSED SYSTEM 9 LEVEL SIMULATION
PROGRAM CODE

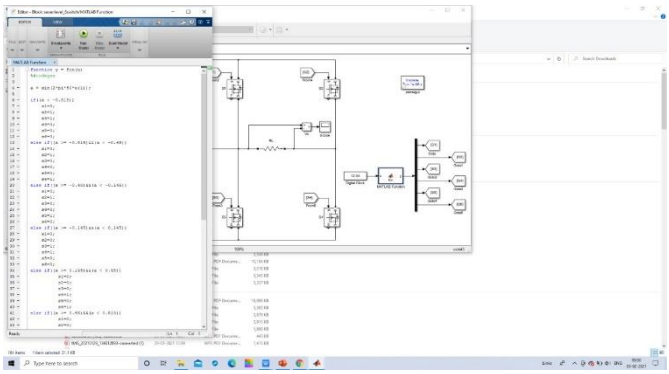
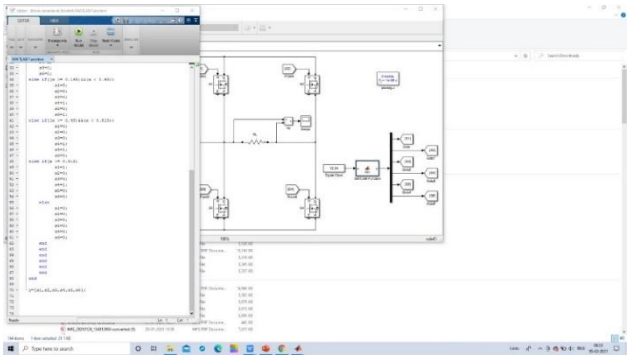


Fig 9: Program code for proposed system



This is the program code of proposed system for 9 level simulation.

CIRCUIT – 9 LEVEL

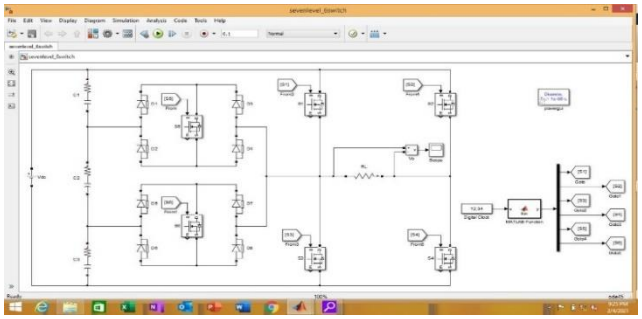


Fig 10:Circuit diagram of 9 level simulation-proposed system.

INPUT VOLTAGE INPUT VOLTAGE = 24V

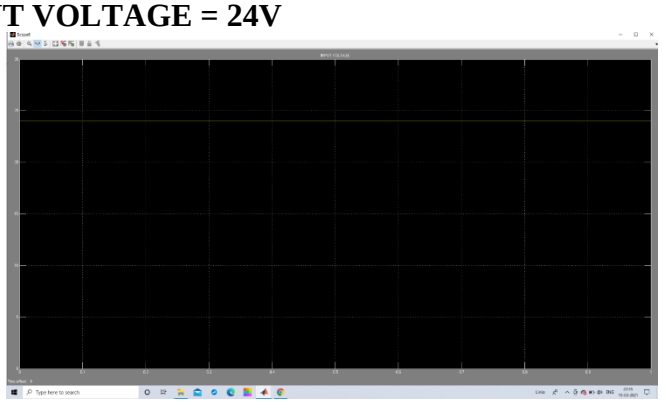


Fig 11:Input voltage

The above figure 11 shows input voltage=24v and the output is taken as 24 volt.

INPUT CURRENT INPUT CURRENT = 0.24A

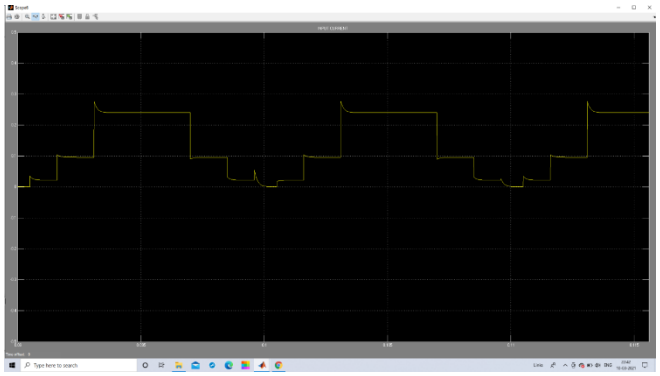


Fig 12:Input current

The above figure 12 shows Input current=0.24A, it is connected across input current.

INPUT POWER **INPUT POWER = 5.9W**

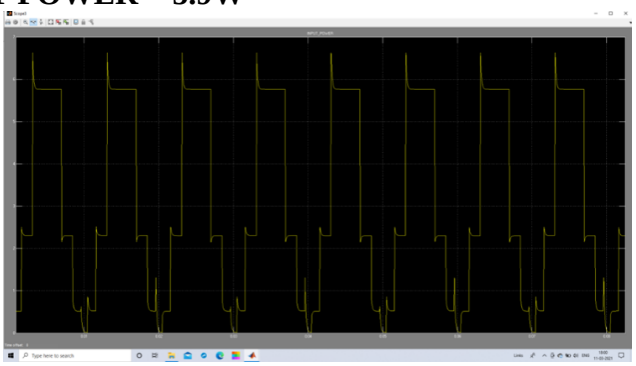


Fig 13:Input power

The above figure 13 shows Input power=5.9W, Product of input current and voltage gives the input power.

OUTPUT VOLTAGE **OUTPUT VOLTAGE = 24V**

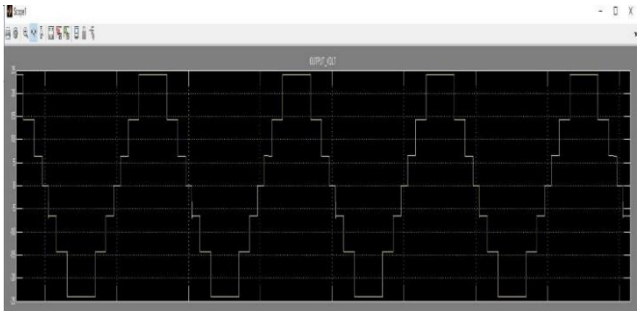


Fig 14:Output voltage

The above figure 14 shows as Scope is connected across input voltage and the output is taken as 24V.

OUTPUT CURRENT **OUTPUT CURRENT = 0.24V**

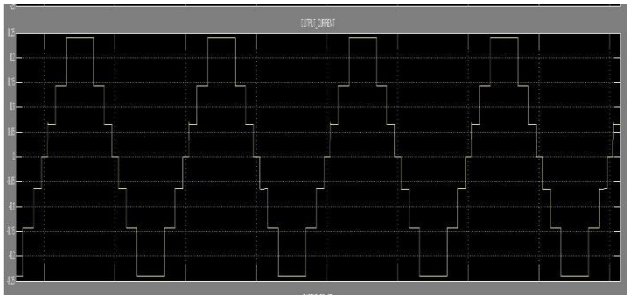


Fig 15:Output current

The above figure 15 shows as output current=0.24A in this simulation we are taken to the output current using mat lab.

OUTPUT POWER **OUTPUT POWER = 5.9W**

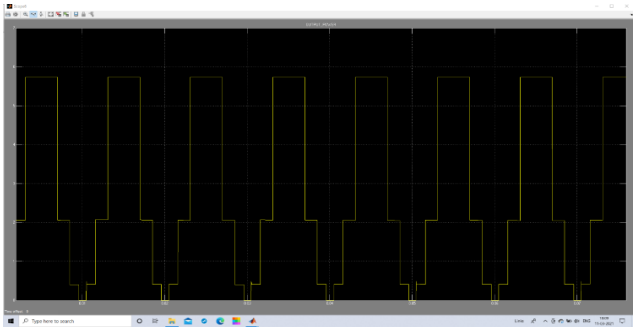


Fig 16:Output power

The above figure 16 shows as output power of 5.9w
We ran simulations for voltage, current, and power in this nine-level inverter. We set the input for 5.9W of power, 24V of voltage, and 0.24A of current. The output was the same. There is less overall harmonic distortion.

CAPACITOR VOLTAGE 1

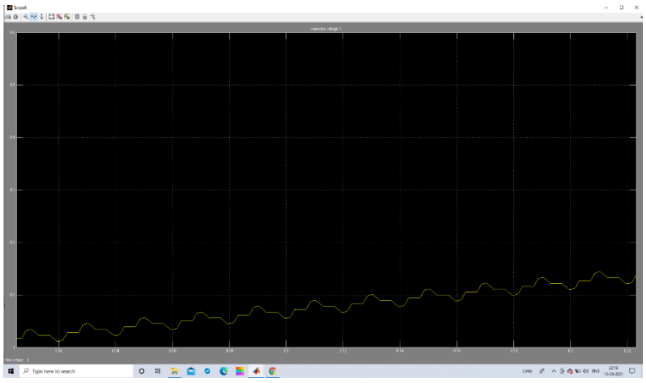


Fig 17:Capacitor voltage 1

The above figure 17 shows as Scope is connected across capacitor1.

CAPACITOR VOLTAGE 2

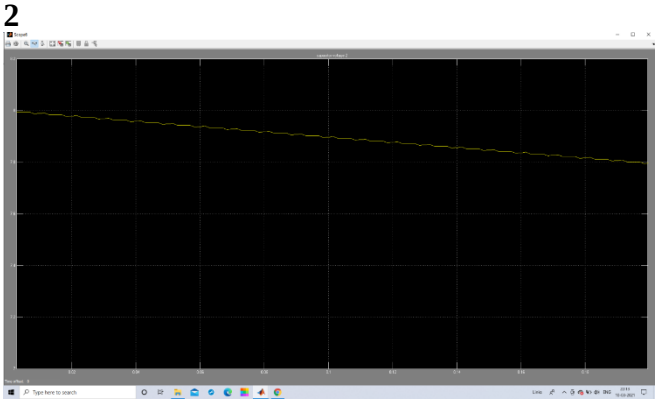


Fig 18:Capacitor voltage 2

The above figure 18 shows as Scope is connected across capacitor2.

CAPACITOR VOLTAGE 3

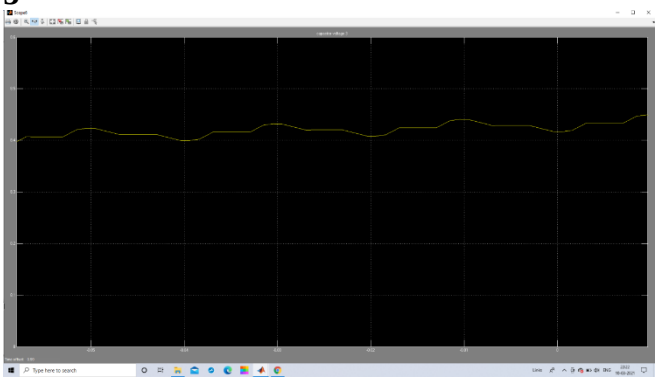


Fig 19:Capacitor voltage 3

The above figure 19 shows as Scope is connected across capacitor3

9 LEVEL THD
TOTAL HARMONIC DISTORTION = 13.99%

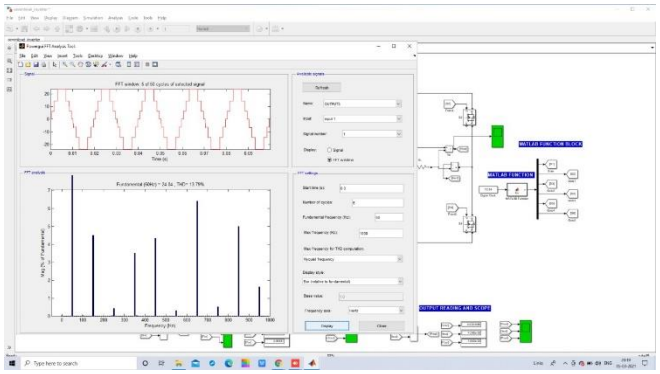


Fig 20:Total harmonic distortion of 9 level

The 9 level inverter has reduced the total harmonic distortion shows as figure 20.

HARDWARE RESULTS

We must utilize the following components in this 9-level inverter: a voltage regulator (9805), a pic microcontroller (DSPIC30F010), LEDs, opt couplers, capacitors, diodes, and a transformer. Here, an IRF940 MOSFET H-bridge, a resistive type load (R load), four diodes coupled to a bridge rectifier, capacitors, and a 12V transformer are given, along with filters.

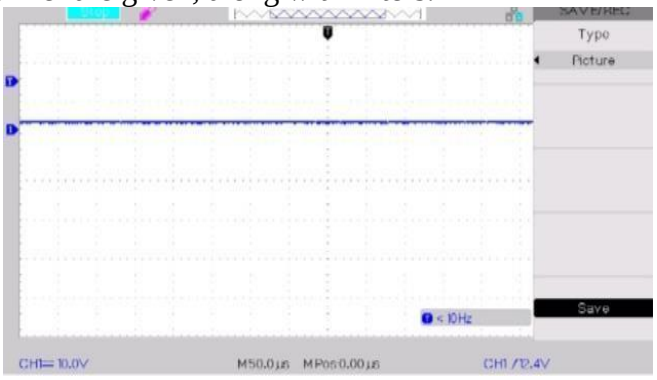


Fig 21:Input voltage

OUTPUT VOLTAGE

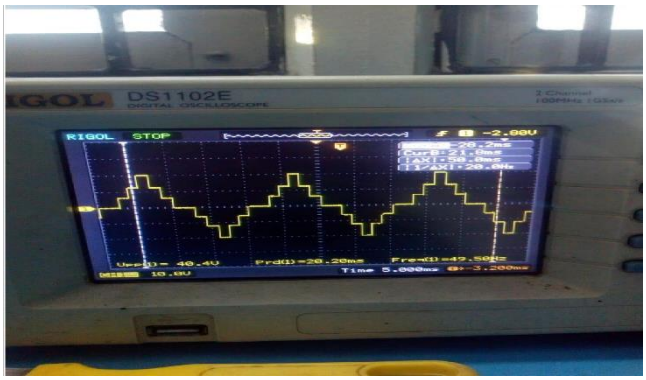


Fig 22: Output voltage

CONCLUSION

The small seven-degree switching design of the energy converter provides stepped forward output waveforms and a low stage of theoretical distortion. This mission design gave the shape of the energy converter a completely unique PWM switching subject. This tool makes use of most effective one reference signal and generates the PWM sign by means of evaluating it with a excessive triangular signal. In these multi-level inverters, 2 ranges of dc voltage are used. Therefore, this configuration is considered as a modern-day cascade converter. The primary modulation index needs to be accomplished and the output voltage needs to be completed at completely distinctive levels. By permitting the addition of another passive components, the strength converter can enhance its overall performance parameters. The THD ranges of the voltage and modern waveforms are measured within IEEE limits.

REFERENCES:

1. Chavarría J, D. Biel, F. Guinjoan, C. Meza, and J. J. Negroni, “Energy- balance control of PV cascaded multilevel grid-connected inverters under level- shifted and phase-shifted PWMs,” IEEE Trans. Ind. Electron., vol. 60, no. 1, pp. 98–111, Jan. 2013.
2. Coppola M, F. D. Napoli, P. Guerriero, D. Iannuzzi, S. Daliento, and A. D. Pizzo, “An FPGA-based advanced control strategy of a grid-tied PV CHB inverter,” IEEE Trans. Power Electron, vol. 31, no. 1, pp. 806–816, Jan. 2016.
3. Farivar G, C. D. Townsend, B. Hredzak, J. Pou, and V. G. Agelidis, “Low- capacitance cascaded H-bridge multilevel StatCom,” IEEE Trans. Power Electron, vol. 32, no. 3, pp. 1944–1954, Mar. 2016.
4. Farivar G, B. Hredzak, and V. G. Agelidis, “A DC-side sensor less cascaded H-bridge multilevel converter-based photovoltaic system,” IEEE Trans. Ind. Electron., vol. 63, no. 9, pp. 4233–4241, July 2016
5. Khoucha F, S. M. Lagoun, K. Marouani, A. Kheloui, and M. E. H. Benbouzid, “Hybrid cascaded H-bridge multilevel-inverter induction-motor-drive direct torque control for automotive applications,” IEEE Trans. Ind. Electron., vol. 59, no. 3, pp. 892– 899, Mar. 2010.
6. Kouro S, M. Malinowski, K. Gopakumar, J. Pou, L. G. Franquelo, B. Wu,M. A. Perez J. Rodriguez and J. I. Leon, “Recent advances and industrial applications of multilevel converters,” IEEE Trans. Ind. Electron., vol. 59, no. 8,pp. 2553– 2580, Aug. 2010.
7. Malinowski M, K. Gopakumar, J. Rodriguez, and M. A. Perez, “A survey on cascaded multilevel inverters,” IEEE Trans. Ind. Electron., vol. 59, no. 9, pp. 2199– 2206, July 2010.
8. Napoles J, A. J. Watson, J. J. Padilla, J. I. Leon, L. G. Franquelo, P. W. Wheeler, and M. A. Aguirre, “Selective harmonic mitigation technique for cascaded H-bridge converters with non equal DC link voltages,” IEEE Trans. Ind. Electron., vol. 60, no. 5, pp. 1963–1991, May 2013.

9. Villanueva E, P. Correa, J. Rodríguez, and M. Pacas, "Control of a single- phase cascaded H-bridge multilevel inverter for grid-connected photovoltaic systems," IEEE Trans. Ind. Electron., vol. 56, no. 11, pp. 4399–4406, Nov. 2009.
10. Vazquez S, J. I. Leon, J. M. Carrasco, L. G. Franquelo, E. Galvan, M. Reyes, J. A. Sanchez, and E. Dominguez, "Analysis of the power balance in the cells of a multilevel cascaded H-bridge converter," IEEE Trans. Ind. Electron., vol. 59, no. 9, pp. 2289–2296, Jul. 2010.