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IMPLEMENTATION OF FIVE LEVEL INVERTER CONSIDERING PV SYSTEM USING MPPT TECHNIQUE

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ABSTRACT

This paper exposes a single phase five level inverter for PV scheme with a new pulse width modulation control scheme. The inverter capability is used to five steps of producing voltages ($V_{dc}/2$, V_{dc}, 0, $-V_{dc}/2$,$-V_{dc}$) from the input voltage. Maximum Power Point Tracking (MPPT) was implemented in Photovoltaic's system along Fuzzy controller. The excepted scheme was proved over simulation along with carryout in a model.

Keywords: photovoltaic (PV) system, MPPT, multilevel inverter, fuzzy logic controller, pulse width modulation (PWM), total harmonic distortion (THD).

I. INTRODUCTION

Energy is essential information in the process of monetary, civil along with technical and improvement. Energy utilization is growing appropriate rapidly, Fossil fuels supply will be depleted in few hundred years and energy crisis problem will be created in the world. Therefore renewable energy resources are essential to develop for energy requirements. Inexhaustible energy generation schemes, particular kind of system is photovoltaic. Similarly a scheme reproduces electric power from modifying sunlight into electric power [1].

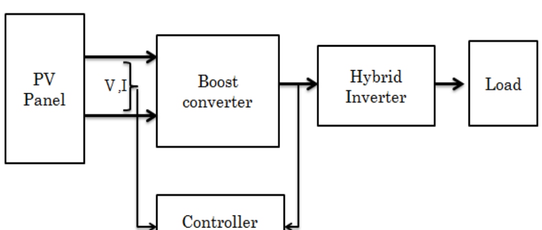

Figure-1. Block diagram of PV system with hybrid converter.

Solar photovoltaic systems can be dispatched energy to loads over multilevel inverter. A single phase five level converter is mostly used for domestic and small power applications in the ranges that are 10KW [2].

2. PHOTOVOLTAIC CELL

2.1 PV modeling

A Photo Electric arrange in the collection of varying photovoltaic cells in series and parallel network.

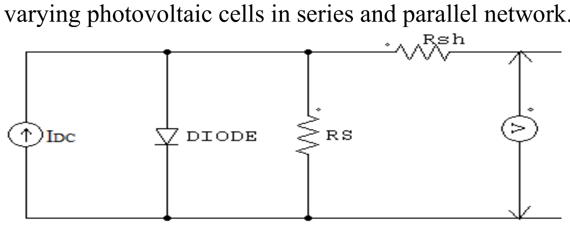

Figure-2. Schematic diagram of photo voltaic cell.

In Series network are in charge being developing the voltage of the section when the parallel network is in charge of raising the current in the supply. Usually a Photovoltaic cell is assembled with the use of a current source as well as an inverted diode joined in parallel into it. It has an individual series and parallel resistance. Series resistance is exactly towards check smart way of the movement of electrons from n to p junction and parallel resistance is through the effluent current [6]. In this circuit we examine a current source (I) additionally a diode and series resistance (R_s). The output current from the photovoltaic array is

$$I = I_{SC}-I_d \quad (1)$$

$$I_d = I_o(e^{qv_d/kt}-1) \quad (2)$$

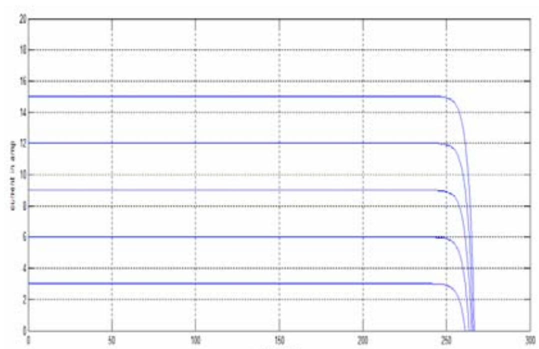

Figure-3. V-I Characteristics of solar panel.

$$I = I_{sc}-I_o(e^{qv_d/KT}-1) \quad (3)$$

Where,

I_o = Reverse saturation current of the diode,
Isc = short circuit current,
I = photovoltaic cell current,
V = PV cell voltage,
Q = Electron charge,
V_d = Voltage across the diode,
K = Boltzmann constant ($1.38*10^{-19}$J/K),
T = Junction Temperature in Kelvin (K)

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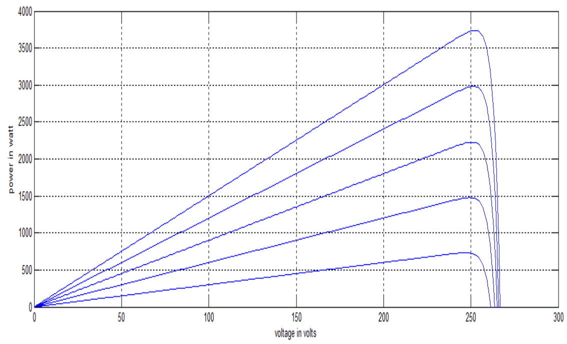
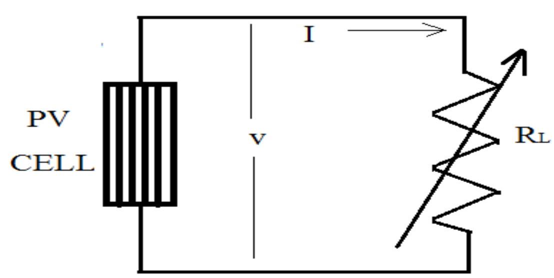


Figure-4. P-V characteristics curve of photovoltaic cell.

The point indicates the best power point at which the output power is high in photo voltaic cell

3. MAXIMUM POWER POINT TRACKING (MPPT)

MPPT implies Maximum Power Point Tracking. MPPT is a power electronic system consisting of a DC chopper (DC-DC converter) to have variable DC from a fixed DC. With control circuitry which controls the output voltage (DC) by controlling duty cycle of DC-DC converter. MPPT stabilizes the voltage for proper operation of load or charging of battery bank irrespective of weather conditions and temperature. MPPT is the interconnection between PV array and electrical load. Load may be battery bank, direct DC load or transmitted to the grid.



It is especially adequate during low light level conditions. These computations result into an output that brings maximum current at the prescribed voltage at each period in time. Low light level situations it will satisfy for the low light level meanwhile detect the current point at which the solar cell gives its optimum power output.

4. MPPT FUZZY LOGIC BASED CONTROLLER

MPPT Fuzzy Logic Controller was constructed and simulated using the Fuzzy Logic Simulink Toolbox represented in figure.

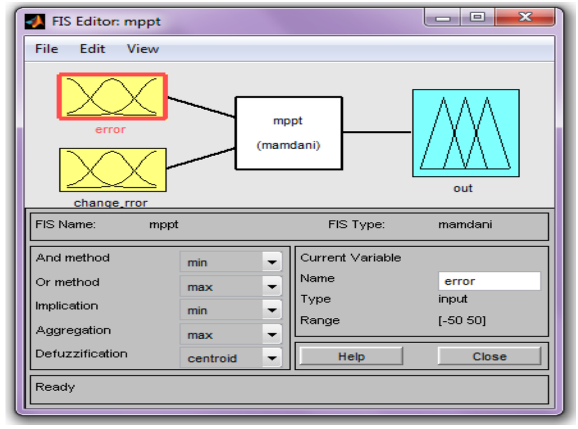


Figure-5. General diagram of fuzzy controller MPPT MATLAB.

Fuzzy logic is simple and robust than conventional PI controller. It is the suitable replacement for the conventional controller. The fuzzy logic controller is consisting of fuzzification, inference & defuzzification. The voltage and change in voltage of the proposed system is taken as an input and duty cycle for the buck converter is considered as an output. Fuzzy rule base is formed as shown in Table-1. Where row represents voltage and column represents change in voltage [5].

The rule base consists of seven membership function for both input and output. Totally forty nine rules formed to get the better duty cycle with variations in the input. Here fuzzy linguistic variable can be expanded as follows.

NVB Negative Very Big, NB is Negative Big, NM is Negative Medium, NVS is Negative Very Small, NS is Negative Small, Z is Zero, PVS is Positive Very Small, PS is Positive Small, PM is Positive Medium, PB is Positive Big and PVB is Positive Very Big.

The rule formation of fuzzy controller is given in the Table-1.

ΔV / V	NB	NM	NS	Z	PS	PM	PB
NB	NVB	NVB	NB	NM	NS	NVS	Z
NM	NVB	NB	NM	NS	NVS	Z	PVS
NS	NB	NM	NS	NVS	Z	PVS	PS
Z	NM	NS	NVS	Z	PVS	PS	PM
PS	NS	NVS	Z	PVS	PS	PM	PB
PM	NVS	Z	PVS	PS	PM	PB	PVB
PB	Z	PVS	PS	PM	PB	PVB	PVB

The error in voltage ($\Delta v = v_{ref} - v_{act}$) has been computed by analyzing the actual voltage along the

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reference voltage. The voltage error and the change in voltage error are the inputs of fuzzy controller and the output is the suitable change in PWM signal. The formation of fuzzy controller is shown in Figure-6.

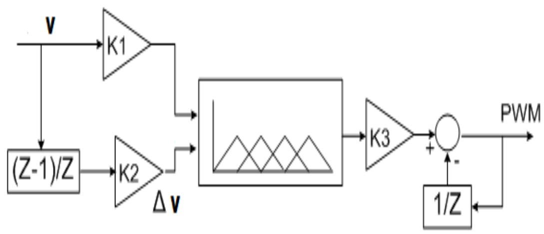

Figure-6. Fuzzy logic controller.

5. PROPOSED MULTILEVEL INVERTER METHODOLOGY

Multilevel inverter is able to satisfy specifications using very high switches, but increase switching losses due to very high switches, disturbance (or) noise, Electromagnetic interference (EMI) to another equipment. Developing its output waveform, cut down its harmonic levels, reduces switches and smaller filter capacity is used.

To obtain a quality output voltage wave forms (or) output current waveforms with minimum amount of ripple content, it's desire high switching frequency additionally various PWM techniques. In this system switching losses are less than the three level inverters, lower filter capacity, less EMI, less total harmonic distortion (THD) complete of which make them compact and economically satisfied.

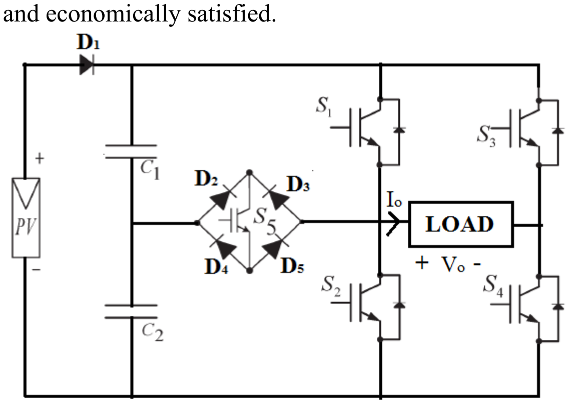

Figure-7. Proposed single phase five level inverter for pv system.

Different methods for many level inverters have been presented past years. Typical types of many level inverters are Diode clamped, Flying Capacitors, and cascaded multilevel inverter. This paper development of altered H-bridge single phase multilevel inverter has two diode enclosed bidirectional switches along with PWM mode. The methodology was enforced to PV system with MPPT and fuzzy logic controller.

The required five level of output voltages were developed as follows.

Maximal positive output (Vdc): S_1 is towards joined the load positive fatal through V_{dc} and S_4 is towards joined the load negative fatal through ground. Entire another controlled switch is absent. The voltage activated through the load fatal is $V_{dc.}$ Figure-8(a) view the current direction that are operating on the indicated point.

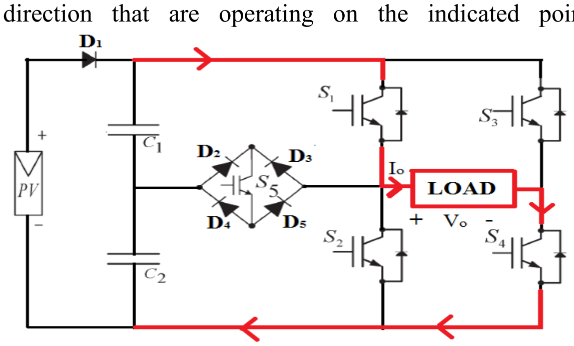

Figure-8(a). Mode 1.

Half of the positive output ($Vdc_{/2}$): The bidirectional switch S5 is towards joined the load positive fatal through V_{dc} and S_4 is towards joined the load negative fatal through ground. Entire another controlled switch is absent. The voltage activated through the load fatal is $V_{dc/2}$ Figure-8(b) Views the current direction that are operating on the indicated point.

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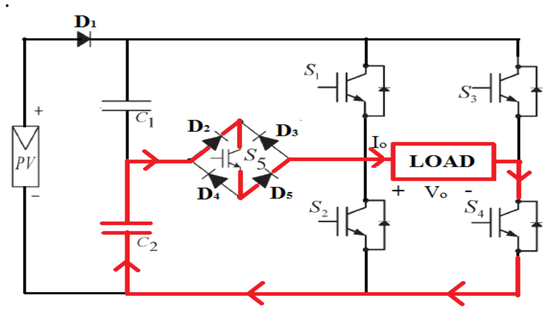

Figure-8(b). Mode 2.

Zero output: The indicated level can be formed by two switching sequences. Switches S_1 and S_2 are upon (or) S_3 and S_4 are upon and all another controlled switch is absent. The fatal ab is short circuit and the voltage activated to the load fatal is zero. Figure-8(c) views the current direction that are operating on the indicated point.

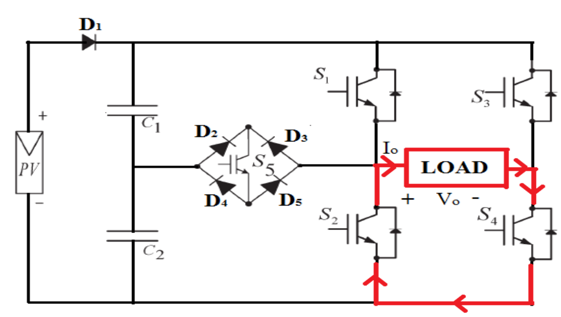

Figure-8(c). Mode 3.

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Half of the negative output ($-V_{dc/2}$) :The switch S_3 is towards joined the load positive fatal through V_{dc} and the bidirectional switch S_5 is towards joined the load negative fatal through ground. Entire another controlled switch is absent. The voltage activated through the load terminals is $-V_{dc./2}$ Figure-8(d) views the current direction that are operating on the indicated point. .

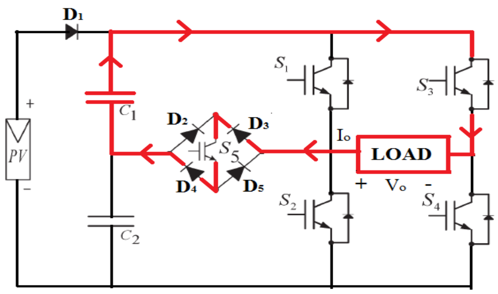

Figure-8(d). Mode 4.

Maximal negative output ($-V_{dc}$) : S_3 is towards joined the load positive fatal through V_{dc} and S_2 is towards joined the load negative fatal through ground. Entire another controlled switch is absent. The voltage activated through the load fatal is $-V_{dc}$ Figure-8(e) views the current direction that are operating on the indicated point.

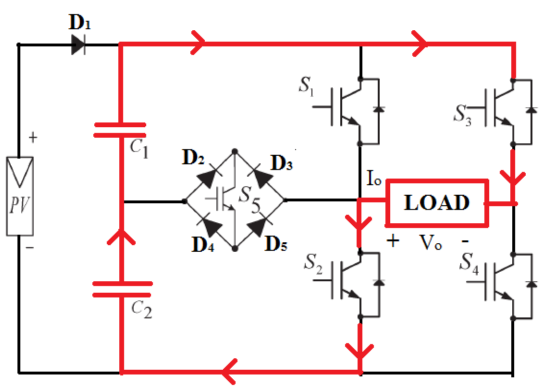

Figure-8(e). Mode 4.

Table1: Switching table for 5 level inverter

Modes	S1	S2	S3	S4	S5	Voltage Levels
Mode 1	ON	OFF	OFF	ON	OFF	V_{dc}
Mode 2	OFF	OFF	OFF	ON	ON	$V_{dc/2}$
Mode 3	OFF	ON	OFF	ON	OFF	Zero
Mode 4	OFF	OFF	ON	OFF	ON	$-V_{dc}/2$
Mode 5	OFF	ON	ON	OFF	OFF	$-V_{dc}$

6. SIMULATION CIRCUIT AND RESULTS

The simulation circuit for expected single-phase five-level inverter topography is shown in Figure-16 .Simulations were implemented by using MATLAB SIMULINK and it also helps to verify the PWM switching action. The converter (DC to AC) accepts a full-bridge structure including an ancillary circuit. PV arrays are joined through the converter (DC to AC) via a DC–DC boost converter.

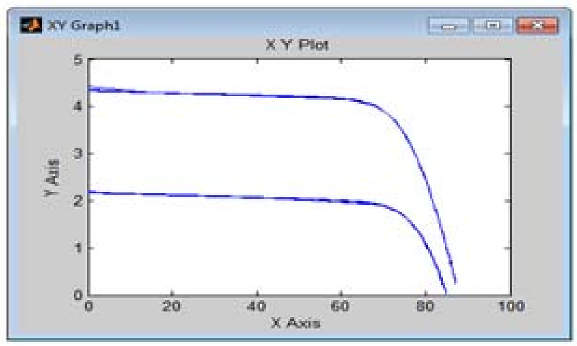

Figure-9. V-I characteristics of solar panel.

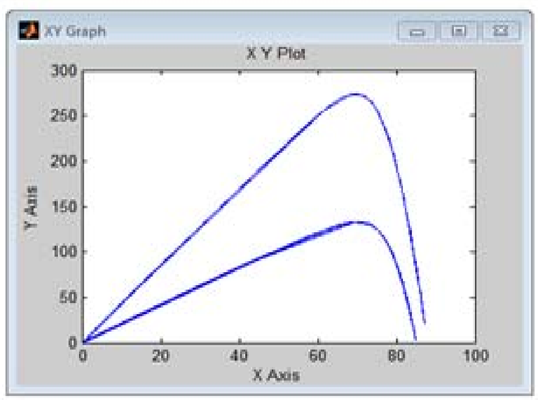

Figure-10. P-V characteristics of solar panel.

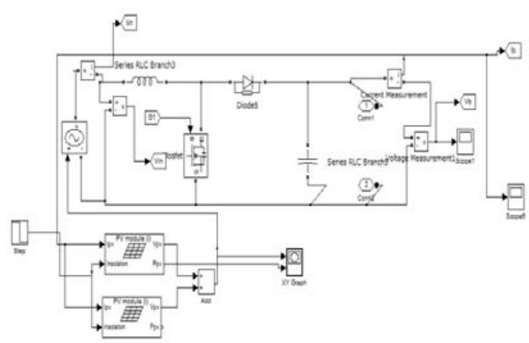

Figure11. A photo voltaic system with DC-DC Converter.

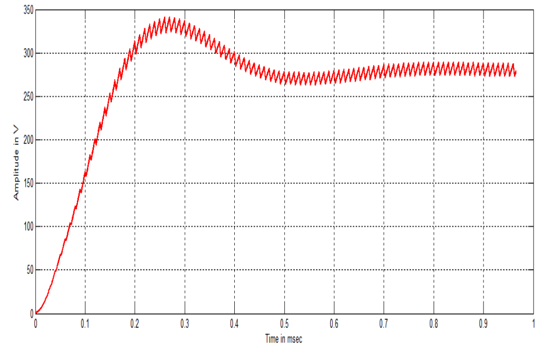

Figure-12. DC-DC converter output voltage.

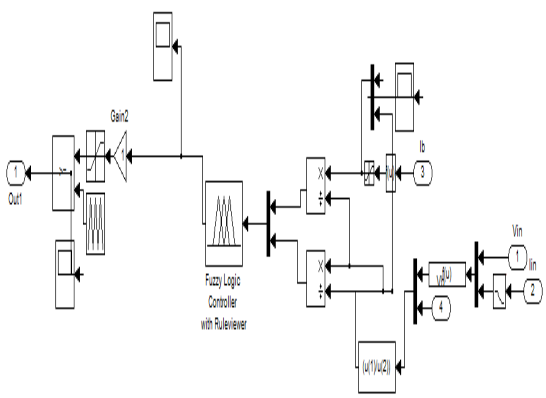

Figure-13. Fuzzy logic control for DC-DC converter.

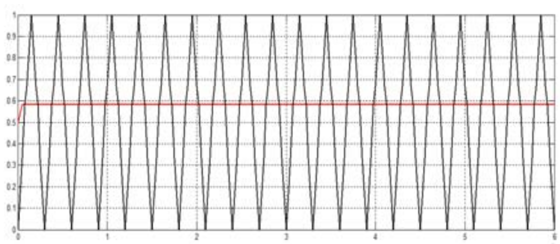

Figure-14. Duty cycle output of fuzzy logic controller and generating switching frequency.

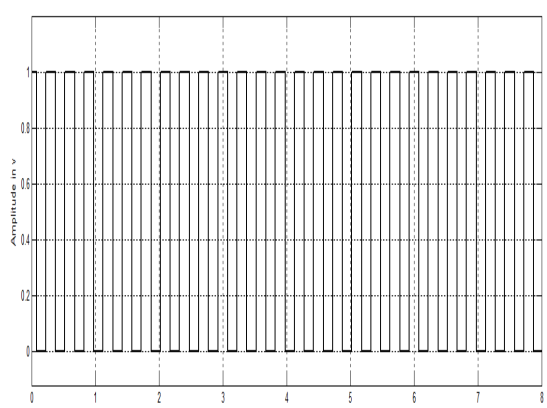

Figure-15. PWM of FLC controller

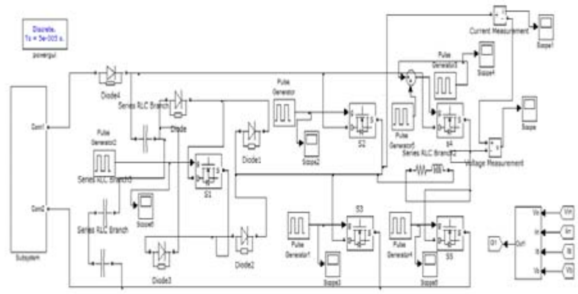

Figure-16. 5-level Hybrid Inverter with RL load.

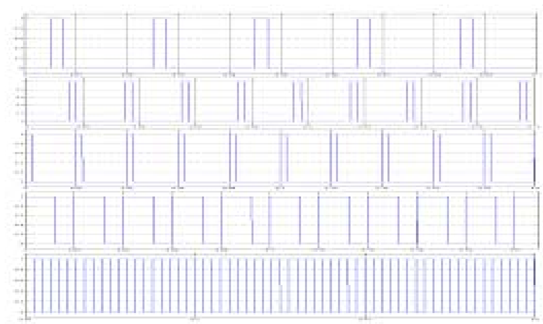

Figure-17. PWM signal for 5level inverter.

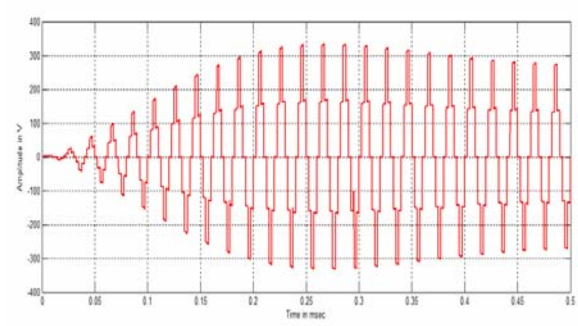

Figure-18. Output voltage for 5 level inverter.

7. PROTEUS MODEL OF IBC WITH MULTILEVEL INVERTER

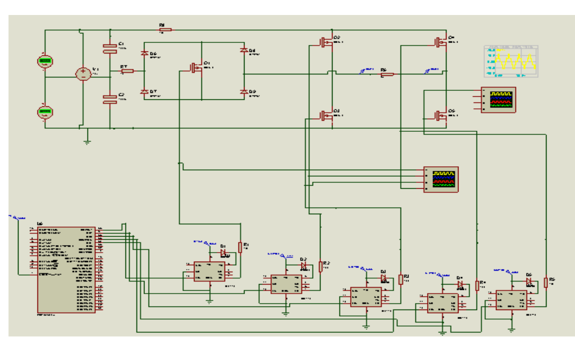

Figure-19. Development of Five level inverter in proteus software.

Figure-20. 2 Five level inverter output pulse.

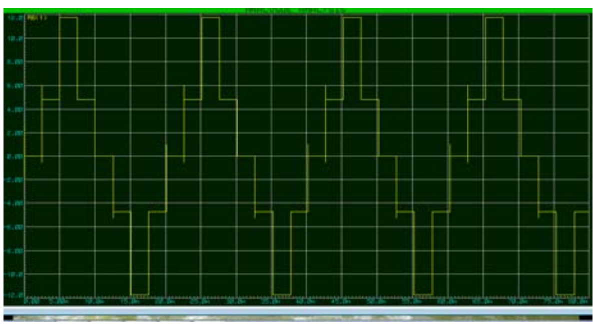

Figure-21. Ouput voltage of five level inverter.

8. HARDWARE DESCRIPTION

The hardware is implemented for seven level inverter, five IRF460 – MOSFET ,IN4007 Diode are used in this design which has high voltage and current carrying capability. Gate Driver of IR2110 circuits are used for boosting the pulses which we get from a microcontroller. PIC16F877A is used for generating required pulses.

Figure-22. 5-level output voltage.

CONCLUSIONS

This paper accepted a single phase five level inverter towards nearly sinusoidal output for PV applications. It employs two reference signals along with a carrier signals to make PWM signals. Choose sum of levels of the inverters output voltage can be carried out by controlling of modulation index. The THD in the five level inverter is fewer related with that in the three level inverter in simulation results.

REFERENCES

[1] Ali Keyhani., Mohammad N. Marwali. and MinDai. "Integration of Green and Renewable Energy in Electric Power Systems", Wiley, January 2010.

[2] P. K. Hinga., T. Ohnishi. and T. Suzuki. “A new PWM inverter for photovoltaic power generation system,” in Conf. Rec. IEEE Power Electron. Spec. Conf. 1994, pp. 391-395.

[3] J. Rodríguez., J. S. Lai. and F. Z. Peng. “Multilevel inverters: A survey of topologies, controls, and applications,” IEEE Trans. Ind. Electron. Vol. 49, no. 4, pp. 724-738, August 2002.

[4] J.M. Carrasco, L. G. Franquelo, J. T. Bialasiewicz, E. Galvan, R.C.PortilloGuisado, M.A.M.Prats, J.I. Leon and N. Moreno-alfonso, “Power-Electronics Systems for the grid integration of renewable energy sources: A survey”, IEEE Trans. Ind. Electronics. Vol.53 no.4, pp. 1002-1016, August 2006.

[5] V.G. Agelidis., D.M. Baker., W.B. Lawrance. and C.V. Nayar. “A multilevel PWM inverter topology for photovoltaic applications. In: proc. IEEE ISIE, Guimaraes, Portugal. 1997, pp. 589-594.

[6] S. Kouro., J.Rebolledo. and J. Rodriguez. ”Reduced switching-frequency-modulation algorithm for high-power multilevel inverters”, IEEE Trans. Ind. Electronics., vol.54, no.5, pp.2894-2901, October 2007.

[7] S. J. Park., F.S. Kang., M. H. Lee. and C. U. Kim. “A new single-phase five-level PWM inverter employing a deadbeat control scheme”, IEEE Trans. Ind. Electronics., vol.18, no.18, pp.831-843, May 2003.

[8] K. Irisawa., T. Saito., I. Takano. and Y. Sawada. “Maximum power point tracking control of photovoltaic generation system under non-uniform insolation by means of monitoring cells. In: Conf. record Twenty-Eighth IEEE photovoltaic spec. Conf. 2000, pp. 1707-1710.

[9] K. Kobayashi., I. Takano and Y. Sawada. “A Study on a two stage maximum power point tracking control of a photovoltaic system under partially shaded insolation conditions. In: IEEE Power Eng. Soc. Gen. Meet. 2003, pp. 2612-2617.