ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Special Issue 2, March 2016

Modeling of Single-Phase Thirteen-Level Asymmetrical Cascaded H-Bridge Inverter for Hybrid Solar & Wind Systems

K.KALAISELVAN
Asst. Prof., Dept. of Electrical & Electronics Engineering,
Bharathiyar Inst. of Engg. For Women,
gripkalai@gmail.com

Abstract- Solar energies have more advantages of zero fuel cost and reduced environmental impacts. The proposed system an Asymmetrical Thirteen level H-Bridge inverter circuit. Two outputs was received from solar PV panels are given to the integrated converter. The maximum power is extracted by using maximum power point tracking system. Integrated converter is DC to DC Boost converter was used to get the maximum output. The output is given to H-inverter which converts the supply from DC to AC and it is applied to load. Operational analysis and simulation results are given for the proposed circuit.

Keywords - Dc-Dc Boost converter, PV panel, FPGA controller, H-Bridge inverter with bi-directional switch circuit, Total harmonic distortion (THD).

I. INTRODUCTION

With increasing concern in renewable energy systems with various sources becomes greater than before. Renewable energy sources such as photovoltaic (PV) and wind energy can be used to enhance the safety, Reliability and sustainability of a power system. Renewable energy resources will increasingly an important part of power generation in the new millennium. There is an enormous need for integrated power converters that are capable of interfacing and controlling several power terminals with low cost and compact structure. The utilization of natural energy is recognized as a new energy source which will eventually replace conventional energy sources. Renewable energy sources do not have the high external cost and social issues. Renewable energy sources such as wind, solar, fuel cell holds more potential to meet our energy demands. This proposal focuses on control of one major renewable-energy source PV and the output of the pv panel is converted to AC by using the Thirteen level inverter asymmetrical H-bridge configuration.

II. HYBRID ENERGY

Hybrid Renewable Energy systems (HRES) are becoming popular for remote area power generation applications due to advances in renewable energy technologies and subsequent rise in prices of petroleum products. A hybrid inverter system usually consists of two or more inverters cascaded together to provide increased system efficiency as well as to reduce the total harmonic distortion (THD).

III. SOLAR ENERGY

Photovoltaic (PV) offers an environmentally friendly source of electricity. Worldwide, photovoltaic account for 500 MW of power generation with an annual growth rate greater than 20%. In the near future photovoltaic power is expected to become more cost effective and will be almost price competitive with traditional sources of energy. With development and breakthrough in new cell materials and power electronics technologies solar power can prove to be an efficient, environmental friendly and safe means of power. In this module the solar cells is a fundamental power conversion unit of a photovoltaic system.

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Special Issue 2, March 2016

IV. MULTILEVEL INVERTER

In recent days there are different configurations are developed for multilevel inverters. In this paper having two H-Bridge inverters with two bi-directional switches are cascaded and formed to achieve the thirteen level output in the load. FPGA controller is used to generate the PWM signals for both the Boost converter and Inverter circuit. There are two different input voltages are given to the two H- Bridge inverters, so this configuration is called as asymmetrical type of inverter. The main advantage of this asymmetrical configuration is the number of switching devices and the number of input voltage sources used in this is reduced, so the total harmonics (THD) also reduced. From a single reference sine wave signal the PWM signal is generated for both the inverter bridges.

V.PROPOSED CIRCUIT DIAGRAM :

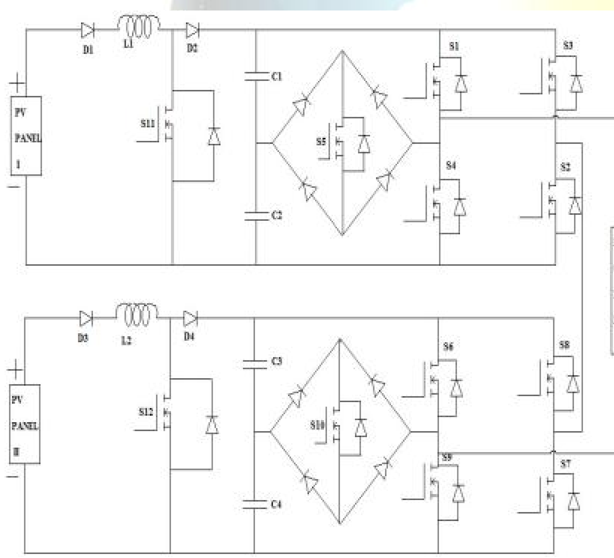

Fig.1.Proposed circuit.

VI. PROPOSED TOPOLOGY:

The proposed single-phase Thirteen - level inverter was developed from the seven - level inverter. It comprises two single-phase conventional H-bridge inverter, two bidirectional switches, and two capacitor voltage divider formed by *C*1, *C*2, *C*3 and C4 as shown in Fig. The modified H-bridge topology is significantly advantageous over other topologies, i.e., less power switch, power diodes, and less capacitors for inverters of the same number of levels. Photovoltaic (PV) arrays were connected to the inverter via a dc–dc boost converter. The power generated by the inverter is to delivered was required because the PV to the load. The dc–dc boost converter arrays had a voltage that was lower than the load voltage. High dc bus voltages are necessary to ensure that power flows from the PV arrays to the load. Proper switching of the inverter can produce thirteen output-voltage levels of(Vdc, $4V$dc$/5$, $3V$dc$/5$, $2V$dc$/5$, Vdc$/5$, 0, $-V$dc, $-4V$dc$/5$, $-3V$dc$/5$, $-2V$dc$/5$, $-V$dc$/5$) from the dc supply voltage. The switching states are easily understand from the mat lab programs for both the H- bridge inverters.

VII. PULSE PATTERN FOR SINGLE PHASE THIRTEEN LEVEL INVERTER

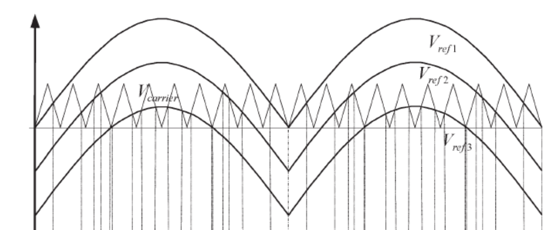

Fig.2.Pwm signal generation.

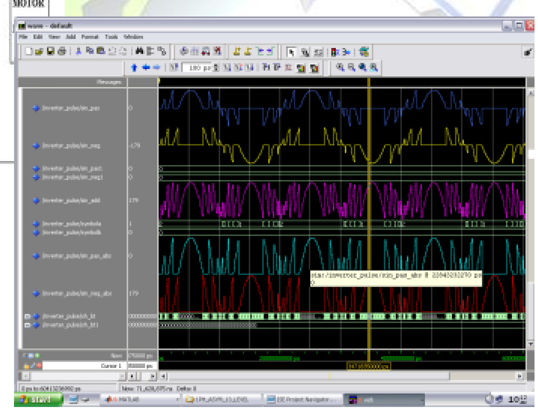

Fig.3.Pulse pattern.

Signal was generated In this thirteen level inverter a single reference sine wave frequency of

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Special Issue 2, March 2016

50 Hz is compared with a triangular carrier wave frequency of 10 KHz. The amplitude of the sine wave is taken in different offset values. There are three offset sine wave is compared with a triangular wave and the PWM.

VII. SIMULATION AND EXPERIMENTAL RESULTS

MATLAB SIMULINK simulated the proposed configuration before it was physically implemented in a prototype. The different amplitude of reference sine wave is compared with a triangular wave and the PWM signal is generated.

A. Simulation Results.

PULSE1,2,3,4,5 FOR INVERTER 1

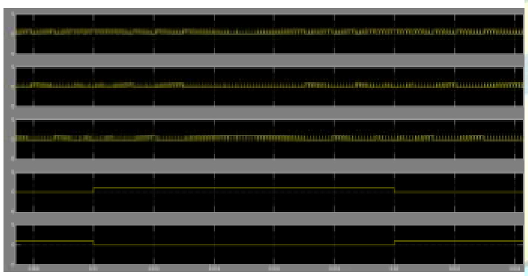

Fig.4.Switching pattern for H-inverter

PULSE1,2,3,4,5 FOR INVERTER 2

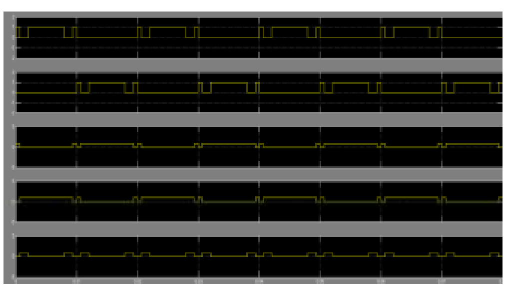

Fig.5.Switching pattern for H-inverter 2

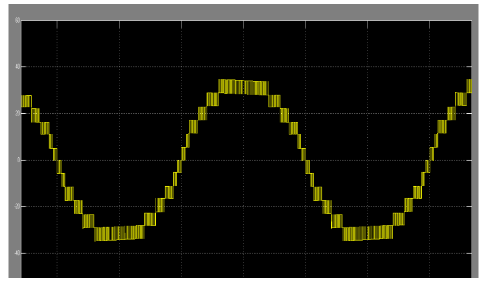

Fig.6.Thirteen level inverter output.

B. Experimental Results.

A FPGA XILINS SPARTAN 3E is used to generate the PWM signals.

Fig.7.Experimental setup for the single – phase thirteen - level PWM inverter.

Fig.8.PWM signals for S1, S2, S3 and S4.

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Special Issue 2, March 2016

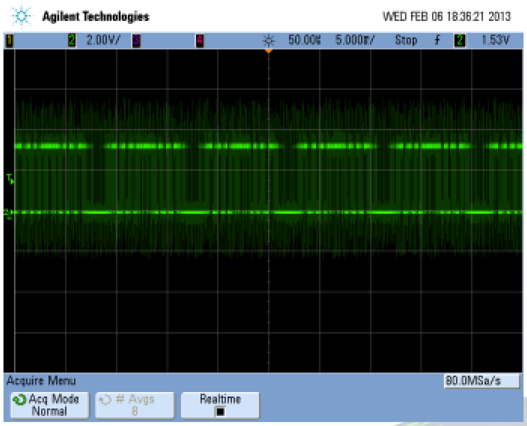

Fig.9.PWM signal for S5.

Fig.10.PWM signals for S6, S7, S8 and S9.

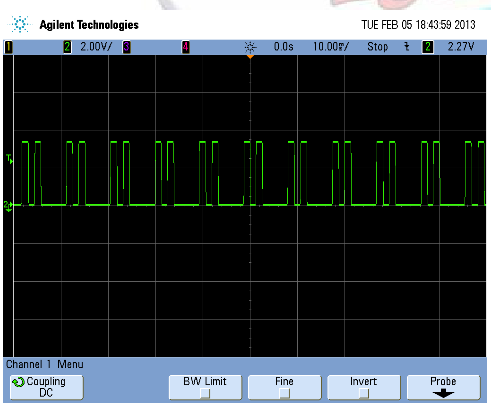

Fig.11.PWM signal for S12.

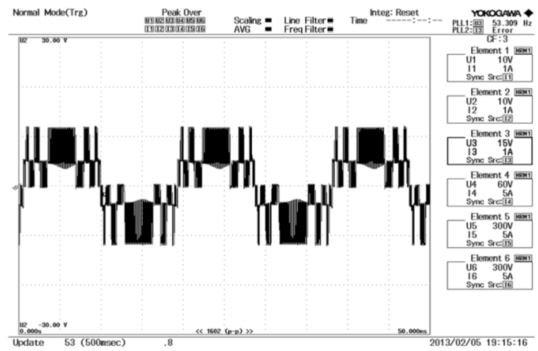

Fig.12.Inverter 1 output.

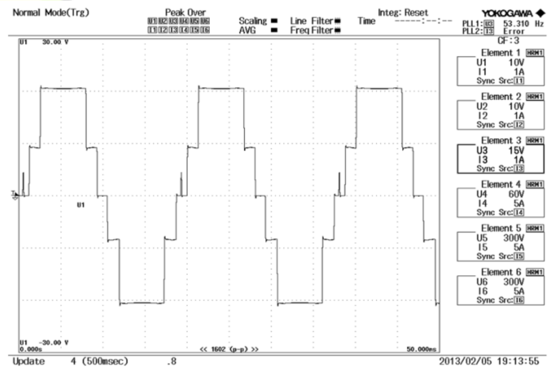

Fig.13.Inverter 2 output.

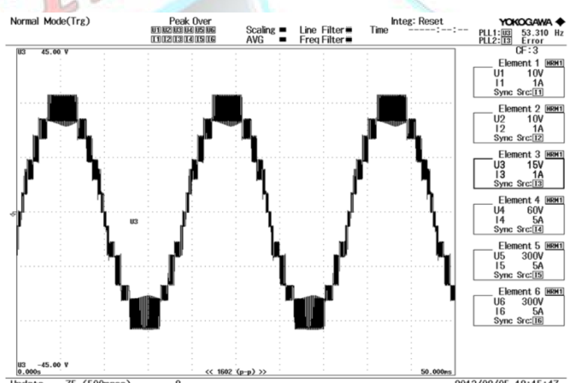

Fig.14.Experimental Result for Cascaded Thirteen-level inverter output.

VII.THD RESULT

By using YOKOGAWA the harmonics result is analyzed.

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Special Issue 2, March 2016

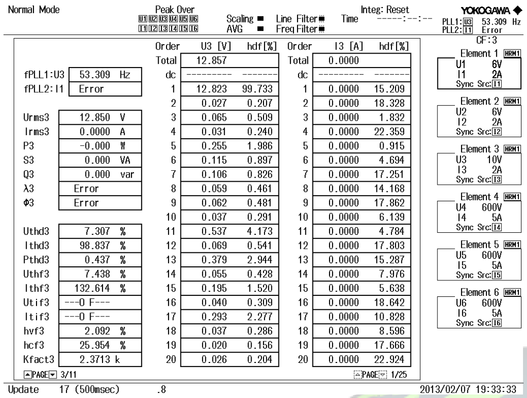

Fig.15.THD Result.

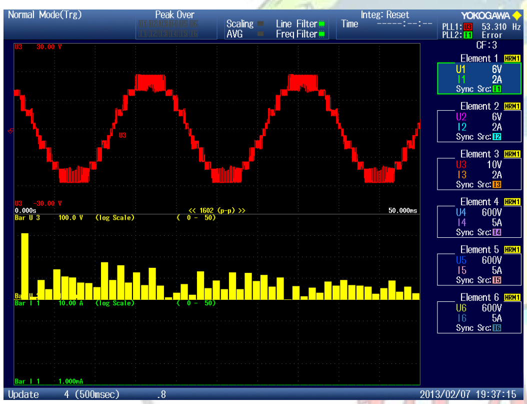

Fig.16.THD bar chart.

IX.CONCLUSION.

Multilevel inverters offer improved output waveforms and lower THD. This paper has presented a novel PWM switching scheme for the proposed multilevel inverter. In this paper only one reference signal and is compared with a triangular wave signal to generate the PWM signals. Here there are two different DC voltage levels are used for the two H-Bridge inverters. So this method of configuration is known as asymmetrical cascaded inverter. By controlling the modulation index and different levels of Dc voltages the thirteen levels's of the output voltage's achieved. A FPGE XILINS SPARTAN 3E is optimized the performance of the inverter. The THD level of this thirteen level inverter is 7.307 %.

X. REFERENCES

[1] M. Calais and V. G. Agelidis, "Multilevel converters for single-phase grid connected photovoltaic systems—An overview," in *Proc. IEEE Int. Symp. Ind. Electron.*, 1998, vol. 1, pp. 224–229.

[2] S. B. Kjaer, J. K. Pedersen, and F. Blaabjerg, "A review of single-phase grid connected inverters for photovoltaic modules," *IEEE Trans. Ind. Appl.*, vol. 41, no. 5, pp. 1292–1306, Sep./Oct. 2005.

[3] 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.

[4] Y. Cheng, C. Qian, M. L. Crow, S. Pekarek, and S. Atcitty, "A comparison of diode-clamped and cascaded multilevel converters for a STATCOM with energy storage," *IEEE Trans. Ind. Electron.*, vol. 53, no. 5, pp. 1512–1521, Oct. 2006.

[5] M. Saeedifard, R. Iravani, and J. Pou, "A space vector modulation strategy for a back-to-back five-level HVDC converter system," *IEEE Trans. Ind. Electron.*, vol. 56, no. 2, pp. 452–466, Feb. 2009.

[6] S. Alepuz, S. Busquets-Monge, J. Bordonau, J. A. M. Velasco, C. A. Silva, J. Pontt, and J. Rodríguez, "Control strategies based on symmetrical components for grid-connected converters under voltage dips," *IEEE Trans. Ind. Electron.*, vol. 56, no. 6, pp. 2162–2173, Jun. 2009.

[7] 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, Aug. 2002.

[8] J. Rodriguez, S. Bernet, B. Wu, J. O. Pontt, and S. Kouro, "Multilevel voltage-source-converter topologies for industrial medium-voltage drives," *IEEE Trans. Ind. Electron.*, vol. 54, no. 6, pp. 2930–2945, Dec. 2007.

[9] M. M. Renge and H. M. Suryawanshi, "Five-level diode clamped inverter to eliminate common mode voltage and reduce dv/dt in medium voltage rating induction motor drives," *IEEE Trans. Power Electron.*, vol. 23, no. 4, pp. 1598–1160, Jul. 2008.

[10] E. Ozdemir, S. Ozdemir, and L. M. Tolbert, "Fundamental-frequencymodulated six-level diode-clamped multilevel inverter for three-phase

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Special Issue 2, March 2016

stand-alone photovoltaic system," *IEEE Trans. Ind. Electron.*, vol. 56, no. 11, pp. 4407–4415, Nov. 2009.
[11] R. Stala, S. Pirog, M. Baszynski, A. Mondzik, A. Penczek, J. Czekonski,and S. Gasiorek, "Results of investigation of multicell converters with balancing circuit—Part I," *IEEE Trans. Ind. Electron.*, vol. 56, no. 7,pp. 2610–2619, Jul. 2009.