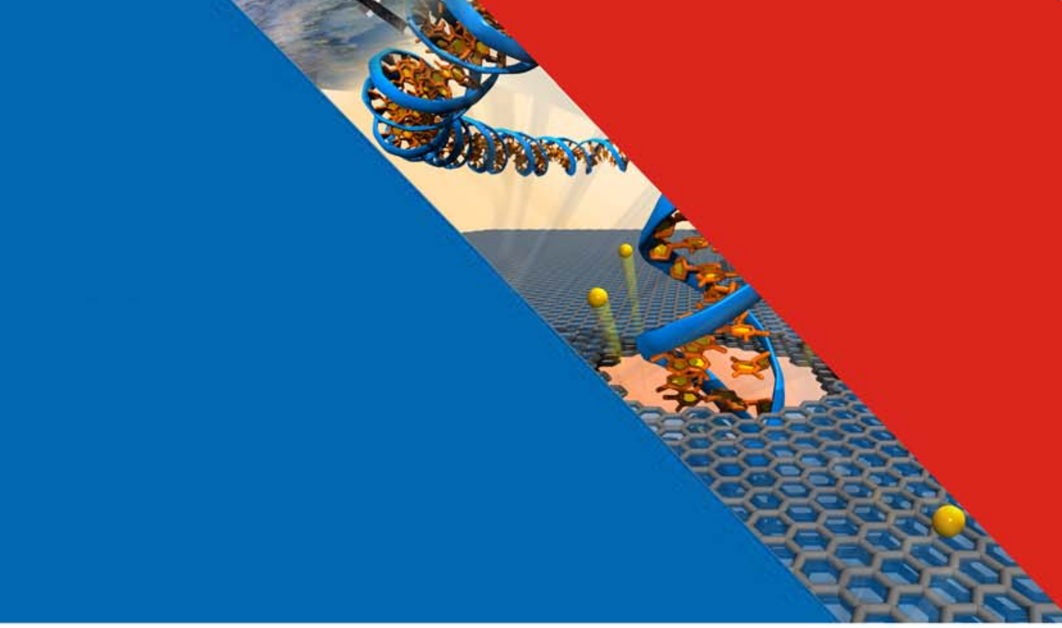
International Journal of Engineering Research and Science & Technology

ISSN : 2319-5991
Vol. 1, No. 2
April 2015

2nd National Conference on "Recent Advances in Science Engineering & Technologies" RASET 2015

Organized by

Department of EEE, Jay Shriram College of Technology, Tirupur, Tamil Nadu, India.



www.ijerst.com

Email: editorijerst@gmail.com or editor@ijerst.com

International Journal of Engineering Research and Science & Technology

ISSN 2319-5991 www.ijerst.com
Special Issue, Vol. 1, No. 2, April 2015
2nd National Conference on "Recent Advances in Science, Engineering&Technologies" RASET-2015

Research Paper

A NEW MULTI LEVEL INVERTER TOPOLOGY FOR GRID INTERCONNECTION OF PV SYSTEMS

E Muthukumar[1], T Sankar[1]*, R Saravanakumar[1] and A Ramakrishnan[1]

Corresponding Author: **T Sankar ✉ Sankaran786@gmail.com*

Renewable energy sources (RES) gain an importance in recent decadesbcause they are pollution free, easily erectable, and limitless. Among RES, Photovoltaic systems are mostly used as they are light, clean and easily installable. Normally PV cells converts sunlight into electricity in the form of dc. A suitable converter is usually needed to convert the dc power into ac power, which is then injecting into the power grid. The Multilevel Inverters [MLI] can be used toconvert the dc into ac for integration of renewable energy sources into the conventional grids. But the conventional MLIs such as Diode Clamped MLIs requires extra diodes in conjunction with the active switches, Flying capacitor MLIsrequires extra Capacitors and control also difficult if the levels increases and the Cascaded H-bridge MLIs requires separate dc sources which limits its use. This paper proposes a new type of multi level Inverter which converts the dc into ac using lessnumber of switches when compared to conventional multilevel Inverters. The proposed Inverter can be used to integrate the Photovoltaic system into Grid, with satisfying the grid requirements such as phase angle, frequency and amplitude of the Grid voltage. Seven levellevel proposed MLI is simulated using Matlab/Simulink environment and theresults are presented in this paper.

Keywords: Grid interconnection, PV system, MLI, Renewable energy sources (RES)

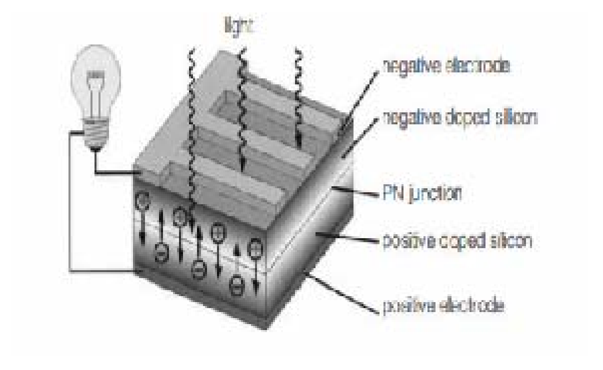
INTRODUCTION

Renewable energy sources are alternatives to ourconventional energy sources such as fossil fuels e.g. oil,coal, gas that are not renewable. The conventional energysources are limited and can be exhausted. Many renewableenergy sources are existing such as solar, wind, biomass,hydro, geothermal and ocean power.Among PV has theadvantage of clean and no pollution, and etc. So, PVsystems are attracting attention in the world [1]. The basicelement of a PV system is the solar cell.A solar cell directlyconverts the energy of sunlight directly into electricity in theform of dc A typical PV cell consists of a p-n junction formed in a semiconductor material similar to a diode asshown in the Figure 1.

Grid interconnection of PV system requires [2-3] anefficient converter to converter the low voltage dc into ac.

1 Bachelor of Engineering(EEE), Jay Shriram Group of Institutions, Tirupur.

Figure 1: Basic structure of a solar cell

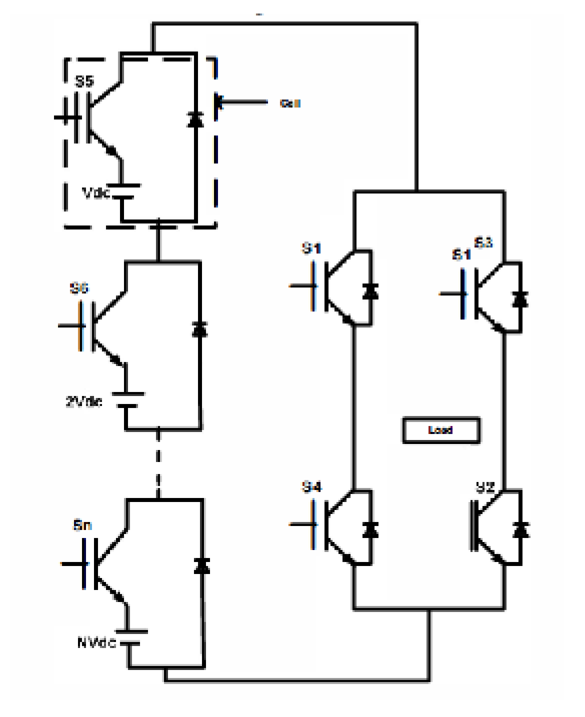


The conventional H-bridge inverter produces a squareoutput, which contains infinite number of odd harmonics and dv/dt stress is also high. Normal PWM inverter canreduces the THD, but switching losses are high and also this inverter is restricted to low power applications. Theimportance of multilevel inverters [MLI] has been increasedsince last few decades[4], [5]. These new types of invertersare suitable for high voltage and high power application dueto their ability to synthesize waveforms with better harmonic spectrum and with less THD. Generally MLIs areclassified into three types: they are 1.Diode Clamped MLIs 2.Flying capacitor MLIs 3.Cascaded H-bridge MLIs. Diodeclamped MLIs require large number of clamping diodes asthe level increases.In flying capacitor MLIs, Switchingutilization and efficiency are poor and also it requires largenumber of capacitors as the level increases and cost is alsohigh. Cascaded H-bridge MLIs are mostly preferred [6] forhigh power applications as the regulation of the DC bus issimple. But it requires separate dc sources and also thecomplexity of the structure is increases as the levelpredominantly increase. In order to address the aboveconcerns, this paper proposes a new type of multilevel inverter which requires less number of DC sources andswitches compared to Cascaded H-bridge MLIs. THD of theoutput voltage is also less when compared to theconventional MLIs. By using this inverter we can efficientlyintegrate the PV into the existing conventional power grid.

PROPOSED TECHNOLOGY

The general structure of proposed new multilevelinverter is shown in the Figure 2.

Figure 2: General structure of proposed new multilevel inverter



It consists of a one H-bridge inverter and 'N' number ofcascaded cells, which are having a dc rating of V dc. Thenumber of levels can be given by the formula:

Number of Levels = [n (n+1) +1]

Where n= Number of cells excluding the H-bridge. Forgenerating + V_{dc} we need turned on switches $S_1$and S_2, for

-V_{dc}, switches S_3 and S_4 has to be turned on, and for zero voltage either switches S_1 and S_3 or switches S_2 and S_4 has to be turned on.

Seven Level Proposed Multilevel Inverter

The seven level proposed inverter uses only sixswitches compared to cascaded H-bridge inverter whichuses ten switches and three separate dc sources. But inproposed inverter, the requirement of separate dc sources isonly two and the switching losses are also low. Using properswitching sequence proposed circuit generates seven levelsin output voltage [7]. Table 1 shows the switching sequenceused for creating seven levels for the output voltage.

Table 1: Switching sequence for proposed seven level inverter

Sw1	Sw2	Sw3	Sw4	Sw5	Sw6	Load voltage
ON	ON	off	off	ON	off	V_{dc}
ON	ON	off	off	off	ON	$2V_{dc}$
ON	ON	off	ON	ON	ON	$3V_{dc}$
off	ON	off	ON	off	off	0
off	Off	ON	ON	ON	off	$-V_{dc}$
off	Off	ON	ON	off	ON	$-2V_{dc}$
off	Off	ON	ON	ON	ON	$-3V_{dc}$

The output waveform has 7 levels: $\pm 3V_{dc}$, $\pm 2V_{dc}$, $\pm V_{dc}$and O.Circuit diagram of proposed seven level multilevelinverter is shown in Figure 3.

For generating seven levels, the proposed inverter uses two cells that mean it contains two switches and two diodes in addition with the one H-bridge.The output voltage waveform of the ideal seven levelinverter is shown in Figure 4.

GRID CONNECTED PV SYSTEM

The block diagram of the proposed grid connected PVsystem is shown in the Figure 5. It consists of a PV system, proposed multi level inverter to interface with the grid.

From Figure 5, the PV cell directly converts the solarenergy into electricity in the form of dc [8]. The voltageobtained from the PV is converted

Figure 3: Circuit diagram of proposed seven level inverter

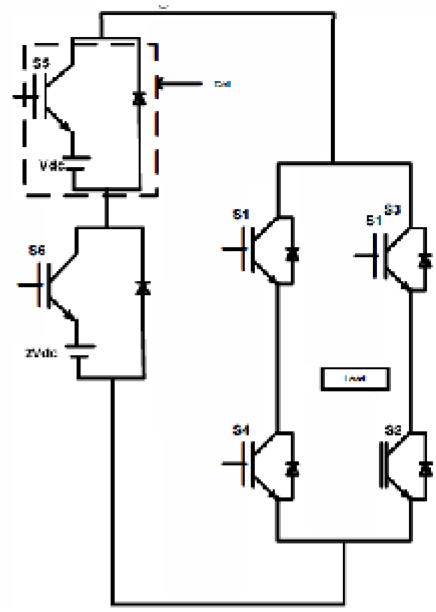


Figure 4: Ideal seven level output voltage waveform

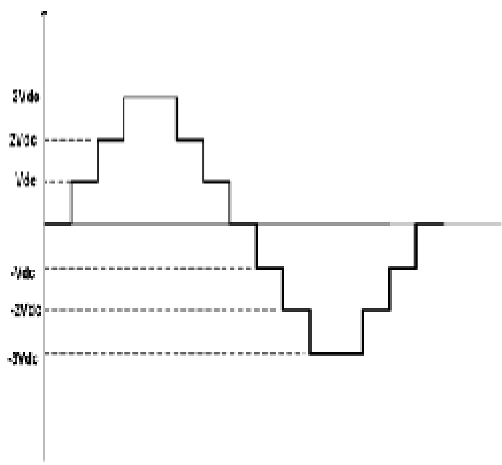
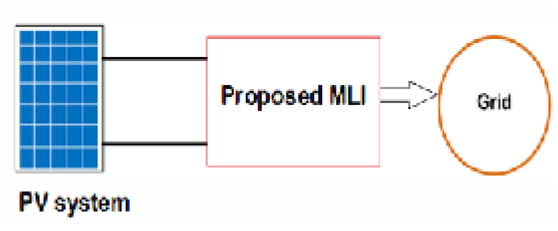


Figure 5: Grid tied photovoltaic system (PV)



into ac using theproposed inverter. Finally the proposed inverter isconnected to the power grid with satisfying the gridrequirements such as phase angle, frequency and amplitudeof the grid voltage.

SIMULATION RESULTS

The following Figures 6 and 7 shows theMatlab/Simulink diagram of proposed seven level MLI and its output voltage waveform.

Figure 6: Matalb / Simulink diagram of proposed seven level MLI

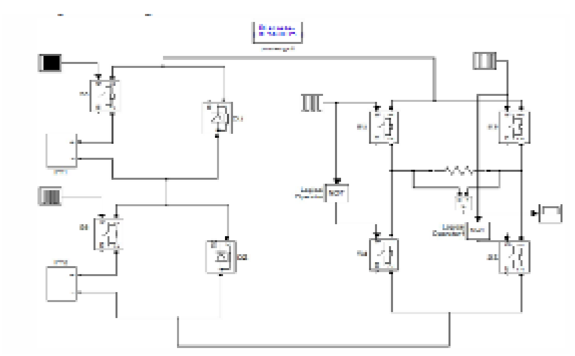
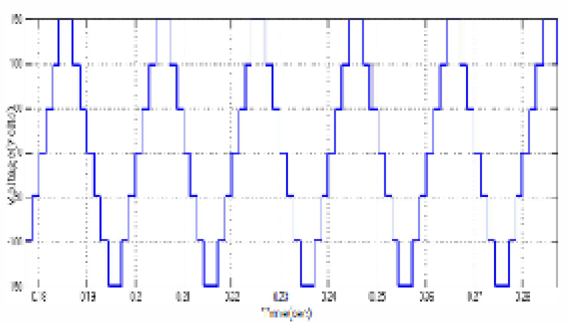


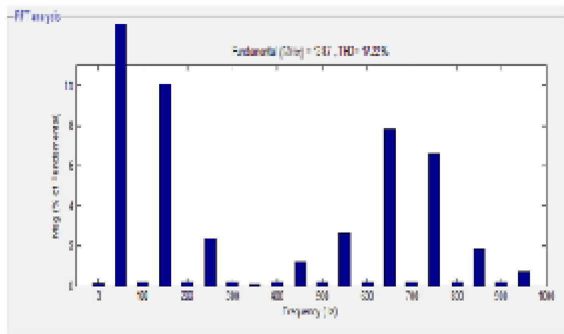
Figure 7: Proposed seven level inverter output voltage



From Figure 7, it is observed that the output voltage ofproposed MLI has seven levels with six switches and twodiodes. The following figure8 shows thespectrumanalysis of seven level output voltage.

From Figure 8, the THD of the proposed seven levelinverter is 17.22%.

Figure 8: THD of the proposed 7-level inverter



Matlab/Simulink diagram of grid connected PV system based on proposed inverter is shown Figure 9.

The following Figure 10 shows the grid voltage and gridconnected current.

Figure 9: Grid connected PV system based on proposed multilevel inverter

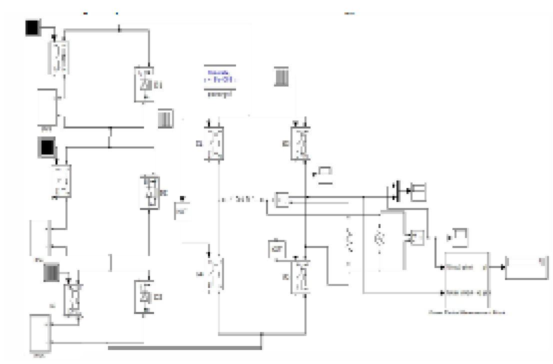
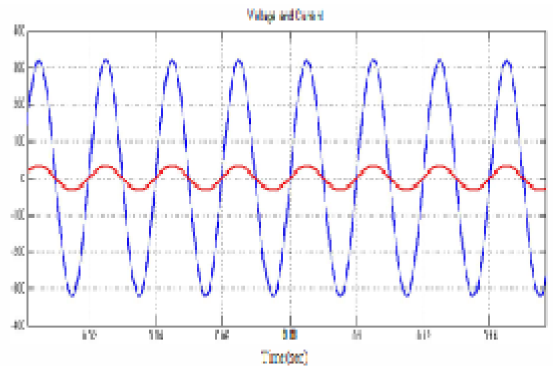


Figure 10: Grid voltage and Grid connected current



From above figure, the phase angle between the gridVoltage and grid Connected Current is zero, i.e. the system works under unity power factor and also it satisfies the grid conditions such as frequency, amplitude of the grid voltage and the phase angle.

CONCLUSION

This paper proposes a grid connected PV system basedon new multilevel inverter with reduced number ofswitches. The proposed multilevel inverter uses less numberof switches, hence the switching losses and cost of inverteris less compared to conventional MUs .Increasing thenumber of output voltage levels reduces the lower orderharmonics and the THD. It's preferred that the outputvoltage has no lower order harmonics because their filteringis so hard. From the results grid voltage and grid connectedcurrent are in phase with each other.

REFERENCES

1. Muhammad H Rashid (2004), "Power Electronics: circuits, Devices and Applications", Pearson Education, Third Edition.

2. Liang T J, Kuo Y C and Chen J F (2001), "Single-stage photovoltaic energy conversion system," *IEE Proceedings Electric Power Applications.* Stevenage, Vol. 14S, pp. 339-344, July 2001.

3. Calais M, Myrzik J, Spooner T, and Agelidis V G (2002), "Inverterfor singlephase grid connected photovoltaic systems-An overview," *in Proc.Power Electron. Spec. Conf*., Feb., Vol. 4, pp. 1995-2000.

4. Lai J S and Peng F Z (1995), "Multilevel Converters - A new breed of power converters," Conference Record of the IEEE-IAS Annual Meeting, pp. 234S-2356.

5. Manjrekar M and Venkataramanan G (1996), "Advanced topologiesand modulation strategies for multilevel inverters," ConferenceRecord of the IEEE-PESC, pp. 1013-10IS.

International Journal of Engineering Research and Science & Technology
Hyderabad, INDIA. Ph: +91-09441351700, 09059645577
E-mail: editorijlerst@gmail.com or editor@ijerst.com
Website: www.ijerst.com

ISSN 2319-5991