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Research paper

A Performance Investigation of a Single Phase Multilevel Inverter Fed Nonlinear Loads for Solar PV Applications

C.Gnanavel[1],M.Rajavelan[2], P.Muthukumar[3], T.Baldwin Immanuel[4]

[1,2]Assistant Professor, [3,4]Associate Professor, [1,2,3,4] Department of Electrical and Electronics Engineering
[1,2,4]AMET Deemed to be University, Chennai, Tamilnadu, India--603112
[3]PVP Siddhartha Institute of Technology, Vijayawada, Andhra Pradesh, India-520007
**Corresponding author E-mail: [1]gnana2007@gmail.com,*
[2]m.rajavelan@gmail.com,[3]muthukumarvlsi@gmail.com,[4]bimmanuelt@gmail.com

Abstract

This paper is design and enlargement of eleven multilevel inverter fed nonlinear loads for solar PV applications. First, control the speed of induction motor, to determine the effectiveness of multilevel inverter and its compare. Second, the open loop control of nonlinear loads according to required operation point of the loads the different operation conditions, fast transient response is obtained. The proposed inverter system is compare with R, RL and Induction motor load performance of inverter and to determine the Total Harmonic Distortion (THD). The proposed system verified simulation result are validate and discussed.

Keywords: *Induction Motor, Multicarrier pulse width modulations, Solar Photovoltaic, Total Harmonic Distortion (THD).*

1. Introduction

The need for vitality is combined non-directly step by step with the improvement of the innovation, the developing way of life and the expansion in total populace [1]. The sun power based vitality limit is bitten by bit expanded expansion of 27.07 GW of the sustainable power source has been accounted for amid the last three and half years under matrix associated inexhaustible power, which incorporates 12.87 GW from sunlight based power, 11.70 GW from wind control, 0.59 from little hydro control and 0.79 from bio power.

One way to deal with understand this is to enhance and organization of sustainable power source including that conceived from sunlight. In a photovoltaic (PV) framework, an inverter is associated with change over DC control delivered from the PV modules into AC control. The inverter is other than evaluated to actualize as indicated by guaranteed control quality benchmarks. In low-control PV applications, single-stage inverters are commonly utilized. Then again, when the PV framework is coupled to the lattice through single-stage inverters, a worry emerges inferable from the way that a specific stage may have all the more such partners as contrasted and different stages in the three-stage arrange [2].

The two-level inverter beats the issue is controlling the power extricated, diminishing the electromagnetic obstruction level, switching loss, lowering the harmonic distortions and decreasing the filter size, multilevel inverters have been presented. There are various configurations to realize the three-phase multilevel circuits with the following three are the most common ones: flying capacitor, cascaded H-bridge and diode clamped or neutral-point-clamped topologies [3,4].

The boost converter, likewise perceived as the step up converter, is the fundamental DC-DC converter arrangement with a yield voltage higher than its info voltage. From the control point of view, the fundamental control frame for a boost converter is fascinating in light of the fact that it is a bilinear framework and furthermore a non-least stage framework as for the yield to be estimated.

The DC-DC support converter is individual happen this issue is flimsy zero elements and voltage following control issue of the essential converter. The proposed inverter is diminished the number of switches limiting total harmonics distortions (THD) and enhance control quality [5].

This inverter topology utilizes five triangular signs with one reference signals, rather than one reference motion, to produce PWM signals for the switches. The control of IMs is a testing issue because of their nonlinear model and parameters variety, however, a large portion of these models are muddled and parameter subordinate. Additionally, they utilize a few suspicions that reason mistake in the numerical model [6,7]. In this proposed MLI encouraged nonlinear loads reduced compare THD and speed of the induction motor for open loop systems. Figure 1 shows to describe basic block diagram proposed research work.

This paper is presents as Sections: I. Describe details of Circuit Topologies in proposed system. Section: II. Modulation strategies for the proposed multilevel inverter. Section: III. Details of Simulation results.

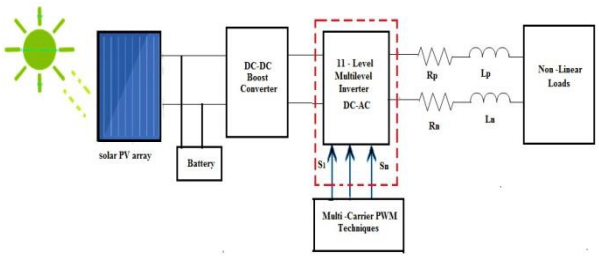

Figure.1: Block diagram of proposed system

2. Circuit Topologies for Proposed 11 Level Inverter

The proposed framework includes just nine unidirectional switches, five diodes, and five symmetrical sun oriented PV sources. The required solar PV sources are associated with DC-DC Converter.

The single-arrange help inverter is worked in a persistent conduction mode. Furthermore, the circuit framework of the single-stage boost inverter. The solar PV rating of V_{oc} =50V, I_{mp}=7A at standard conditions (1000 W/m^2, 25ºC) can supplied to DC-DC Converter boost the voltage 98V. The boost is connected to MLI has absorbed on reducing the difficulty of MLI while maximizing the levels in the output voltage to improve power quality.

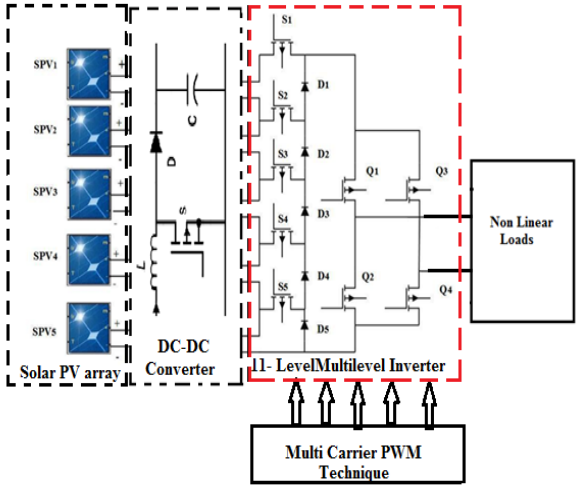

Figure. 2: Proposed of eleven level inverter with nonlinear loads

The proposed inverter is fed to induction motor drive and these works were control to high speed region, and low speed region is not observed. Hereafter, the most important contribution of this paper compared THD with other nonlinear loads is to investigate the dynamic performance.

The proposed inverter have been multicarrier PWM injected sinusoidal waveform with low harmonic distortion. In order to produce sinusoidal current, sinusoidal PWM is used because it is one of the greatest functioning methods. Sinusoidal PWM is attained by associating a high-frequency carrier with a low-frequency sinusoid, which is the controlling or reference signal. The proposed inverter is fed to nonlinear loads [8,9]. The most effective five triangular waveform to compare with sinusoidal generate PWM pulse given into inverter to determine the THD value for R, RL, and Induction motor. The induction motor has been tested to control of speed and torque. The proposed inverter is operating as per switch combination Table 1.

Table .1: Switching Combinations

S_1	S_2	S_3	S_4	S_5	Q_1	Q_2	Q_3	Q_4	Output Voltage (V_o)
0	0	0	0	1	1	0	0	1	+1/5V_{dc}
0	0	0	1	0	1	0	0	1	+2/5V_{dc}
0	0	1	0	0	1	0	0	1	+3/5V_{dc}
0	1	0	0	0	1	0	0	1	+4/5V_{dc}
1	0	0	0	0	1	0	0	1	+V_{dc}
0	0	0	0	0	0	1	1	0	0
0	0	0	0	1	0	1	1	0	-1/5V_{dc}
0	0	0	1	0	0	1	1	0	- 2/5V_{dc}
0	0	1	0	0	0	1	1	0	-3/5V_{dc}
0	1	0	0	0	0	1	1	0	-4/5V_{dc}
1	0	0	0	0	0	1	1	0	-V_{dc}

The proposed MLI topology would be verified with single-input multi-output boost converter for PV application. By employing the proper sequence of switching, the proposed inverter can produce an 11 level output voltage with less number of conduction switches in each voltage step.

The proposed inverter can be designed based on switching sequence of positive half cycle (S_1 D_1, S_2 D_2, S_3 D_3,S_4 D_4, S_5 D_5,Q_1 Q_4) and negative half cycle (S_1 D_1, S_2 D_2, S_3 D_3, S_4 D_4, S_5 D_6, Q_2 Q_3) randomly to operated solar photo voltaic cells (SPV_1,SPV_2,SPV_3,SPV_4,SPV_5). The switching device of an MLI is proportional to the number of its voltage level. The modes of operation for generating symmetric 11- level output voltage.

3. Modulation Strategies for the Proposed Multilevel Inverter

A number of modulation approaches are used in multilevel power conversion applications.

They can generally be classified into three categories:

(1) Fundamental frequency switching method

(2) Space Vector pulse method

(3) Carrier based pules method

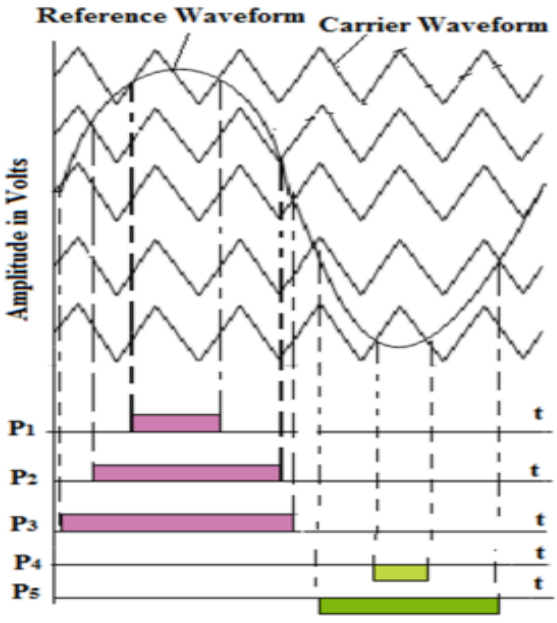

Figure.3: Multicarrier arrangement of PWM

The PWM methods for inverter, carrier based PWM methods and space vector methods are regularly used but when the number of output level is additional than five, the

space vector method will be very complicated with the increase of switching states [10,11&12]. The carrier based PWM method is preferred under this condition in multilevel inverters. This paper focuses on carrier based PWM techniques which have been compare for use in multilevel inverter topologies by using multiple carriers. Modulation of a multilevel converter is quite stimulating, and much of the described research is based on somewhat simulations

4. Simulation Results

The effectiveness of the proposed inverter with nonlinear loads based open loop controller is validated by simulation results under different operating conditions and tested nonlinear loads. Simulations are achieved using MATLAB/Simulink on a single phase induction motor. Figure 4 shows the simulation five number of solar PV panel array maintain symmetrical PV voltage and uses of DC-DC converter boost the voltage. The unipolar PWM sinusoidal reference with five triangular carriers is utilized for generating the switching pulses of the proposed multilevel inverter configuration switches in simulated shows in Figure 5. Figure 6 -9 show the simulate inverter 11-level output voltage and their R, RL and Induction motor harmonics parameter determine and compare THD.

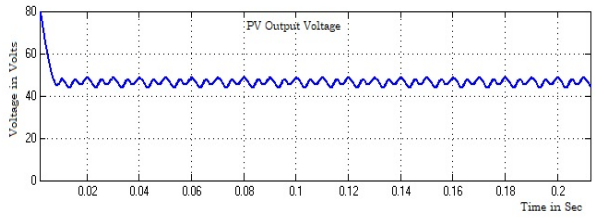

Figure .4 : Symmetrical solar PV voltage

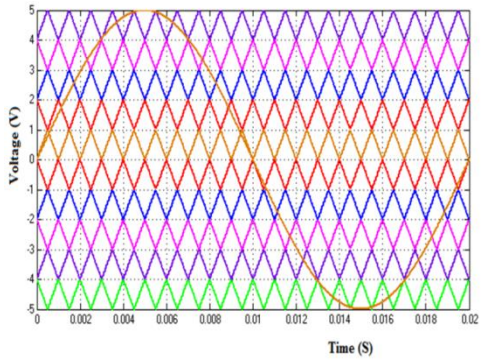

Figure 5: Multicarrier PWM of inverter

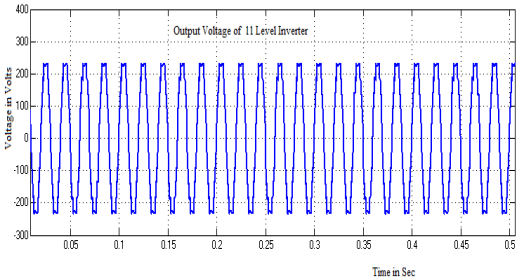

Figure.6: Output voltage inverter with R load

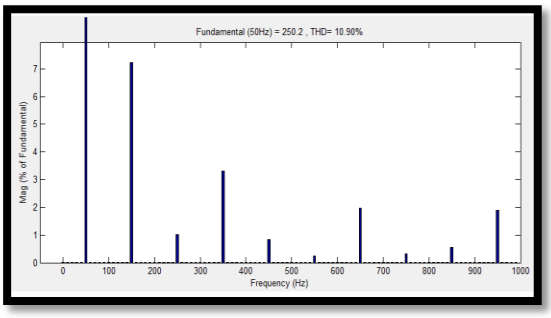

Figure.7: Harmonic Distortion in R Load

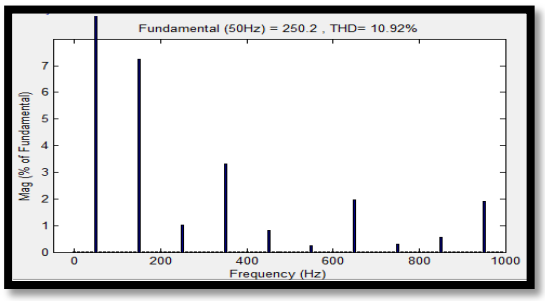

Figure.8: Harmonic Distortion in RL Load

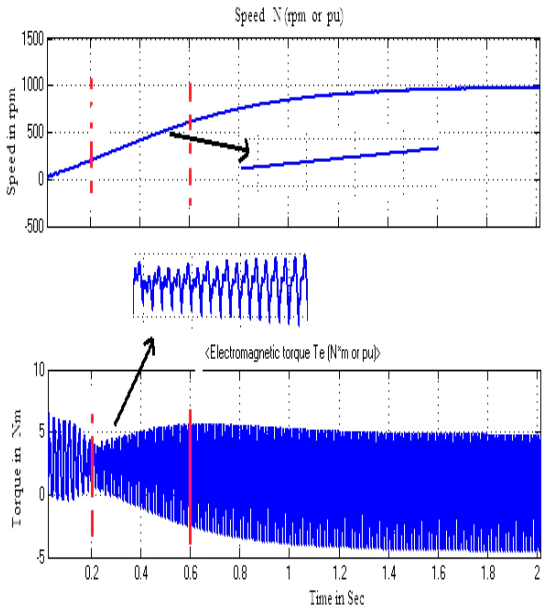

Figure. 9: Harmonic Distortion in Induction Motor

Table 2: Comparisons of Total harmonics distortion

Inverter	Total Harmonics Distortion		
	R Load	RL Load	Induction Motor
Proposed 11– Level MLI	10.90%	10.92%	18.29%

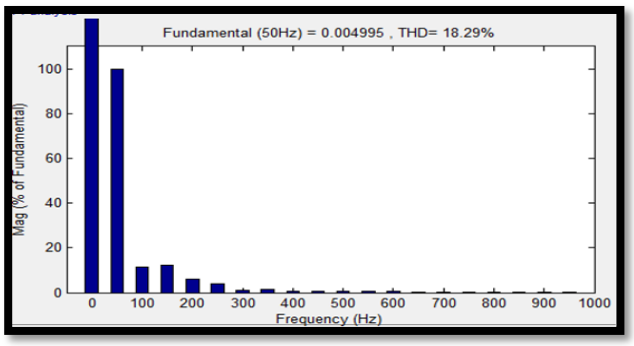

Figure 10: Speed – Torque Characteristics

The amplitude is as a result of the inductance value used. It can be further reduced with the use of a bigger inductance value. The results reveal the efficiency of the proposed system. This paper is focused in without any controller and filters with the suggested modification mechanism in maintaining the good performance of the inverter to produce good quality of the load voltage, even during the presence of disturbances in Table II. The proposed method is used only open loop control with different types of nonlinear loads. RL and induction motor load more inductance affect to disturbance of output voltage shows Figure 10 .The simulate induction motor with proposed inverter speed - torque both can be disturbances of 0.2 to 0.6 time period. This problem overcome and reduce the disturbances move to closed operation. The experimental to implemented modular level multilevel inverter Figure11 and 12. The simulation result experimental verified.

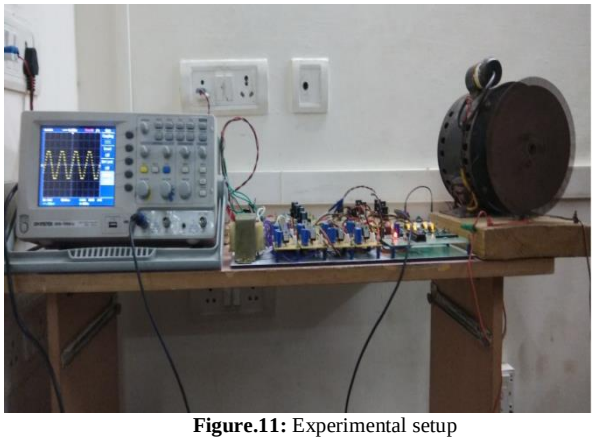

Figure.11: Experimental setup

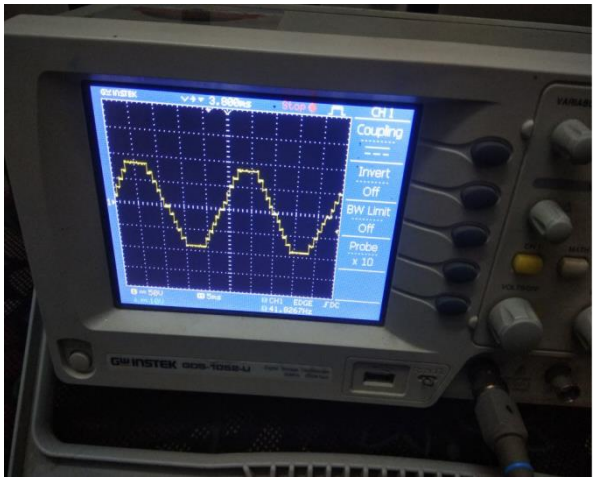

Figure.12: Output voltage of inverter

5. Conclusion

The performance of the proposed method is investigated different types of nonlinear loads. The obtained results, first determined by using the simulation model developed on MATLAB platform. Unlike actual implementation, the simulation model. The inverter output voltage waveform also appears to be different after the load changes due load impedance to affect output voltage of multilevel inverter. The open loop controller using nonlinear load without filters the performance of the inverter to produce good quality of the load. The successful comparisons of individual loads performances to provide designers with preliminary inverter efficiently.

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