Performance and Analysis with Power Quality Improvement with Induction Motor in Electric Drive

Akram Ansari, Shobhit Jain, S. P. Phulambikar, Sanjeev Gupta

***Abstract*— The Objective of the present analysis is to get the reduced harmonics AC results which obtained by reduced number of power electronics switches and increases the voltage level. This voltage level received through the using asymmetrically DC voltage Source and Analysis on the basis of non linear load of three phase induction motor ,theoretically and simulation analysis are through the MATLAB/SIMULINK shows thespeed, torque characteristics of the motor and seven level output voltage of inverter. The seven level and nine level inverter with reduced total harmonic distortion can be acheived.**

***Index Terms*— multilevel inverter, multilevel converter, symmetrical, dc sources, bidirectional Switch, and Induction motor,Total harmonic distortion.**

I. INTRODUCTION

Multilevel inverters have been under research and development for more than three decades and have been found successful industrial applications. However, this is still a technology under development and many new contributions and new commercial topologies have been reported in the last few years. The aim of this dissertation is to group and review recent contributions in order to establish the current state of the art and trends of the technology to provide readers with a comprehensive and insightful review of where multilevel converter technology stands and is heading. This chapter first presents a brief overview of well established multilevel inverters strongly oriented to their current state in industrial applications and then centers the discussion on the new multilevel inverters that have made their way into the industry. Multilevel inverters have been attracting increasing interest recently the main reasons are increased power ratings improved harmonic performance and reduced electromagnetic interference (EMI) emission that can be archived with multiple dc levels that are synthesis of the output voltage waveform. In particular multilevel inverters have abundant demand in applications such as medium voltage industrial drives, electric vehicles and grid connected photovoltaic systems.

The present work provides a solution to design an efficient multilevel topology which is suited for medium and high power applications. In the subsequent sections the research background is discussed in detailed. Motivation and objectives are clearly outlined.

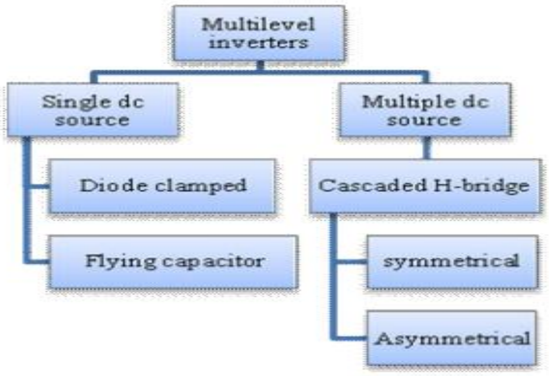

Fig.1 Types of multi level inverter

The different types of MLI are diode clamped, flying capacitor, cascaded MLI. Diode clamped requires more no of diodes and flying capacitor has capacitor balancing problem The cascaded H-bridge inverters having more no of advantages such as modular structure compare to other topologies such as modular structure and less no of components it is one of the topologies proposed for drive applications which meet the requirements such as high power rating with reduced THD and switching losses. The asymmetric MLI reduces the number of input DC sources required and increases the number of levels in the output. The modulation strategy used for reducing the THD is the level shifted carrier based PWMtechnique and the carriers used are the triangular waves with same amplitude and frequency.This device has the high power rating, less switching losses,less conduction loss and it has the ability to with stand high switching stresses in the series connection employed in this inverter design.. This method proves that the THD in the seven level output can be highly reduced by CL SPWM technique and most importantly the performance characteristics of the motor load can be improved by implementing the proposed idea.[1-4]. An induction or asynchronous motor is an AC electric motor in which the electric current in the rotor needed to produce torque is obtained by electromagnetic induction from the magnetic field of the stator winding. An induction motor therefore does not require mechanical commutation, & the separate-excitation or self-excitation for all or part of the energy transferred from stator to rotor, in universal, & in DC and large synchronous motors. This induction motor's rotor can either wound type or squirrel-cage type[6].The utility power supply is of constant frequency and it is 50Hz.Since the speed of AC machines is dependent on to the frequency of the input voltages and current they have a fixed speed when supplied from power utilities. A number of modern

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manufacturing processes such as machine tools require variable speed. The introduction of variable speed drives increases the automation and productivity and in the process, efficiency. Nearly 65% of the total electric energy is consumed by the electric motors, thus decrease in the energy input & increase in the efficiency of the mechanical transmission reduces the energy consumption. The system efficiency can be increased from 15% to 27% by the introduction of variable speed of drive operation in the place of constant speed operation.Induction motors with squirrel cage rotors are the work horse because of their low cost and rugged construction. When operated directly from the line voltages(50Hz utility input at essentially a constant voltage)an induction motor operates at a nearly constant speed.However by means of power electronic converts it is possible to vary the speed of Induction motor.In applications such as uninterruptible AC power supplies and AC motor drives, three phase inverters are commonly used to supply 3 phase loads. It is possible to supply a 3 phase by means of three separate single phase inverters. Where each inverter produces an output displaced by 120 degrees wrt to each other. Voltage source inverters (VSI) together with induction motors are being used ever more frequently as drive units in various fields. In particular they are frequently used in controlling the drives which improves the static and dynamic properties of the drive. The widespread implementation of the variable speed drives is also challenging designers and users to investigate the steady state and transient operating conditions of these drives. Computer-aided analysis and synthesis packages such as MATLAB/SIMULINK have been used in power electronics.

II. MULTI LEVEL INVERTER TOPOLOGIES:

Multilevel inverters are good power quality, and higher Voltage capability. Multilevel inverter not only achieves higher power rating but also enables the use of renewable energy sources. Renewable energy sourcessuch as photovoltaic, wind and fuel cell can be easily interfaced to a multilevel inverter system. Multilevel inverter includes an array of power semiconductor devices and capacitors voltage sources, the output of which generates voltages with stepped waveforms [14-15]. The commutation of the switches permits the addition of the capacitor voltages to obtain high voltage at the output, while the power semiconductors have to withstand only reduced voltages.

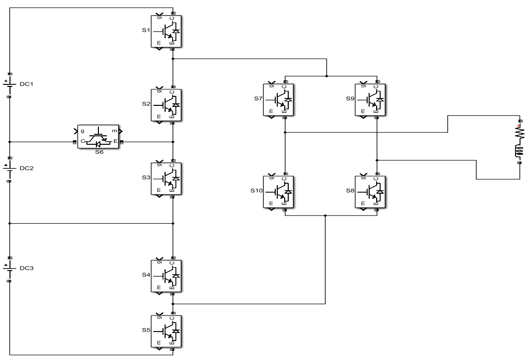


Fig.2 seven level inverter

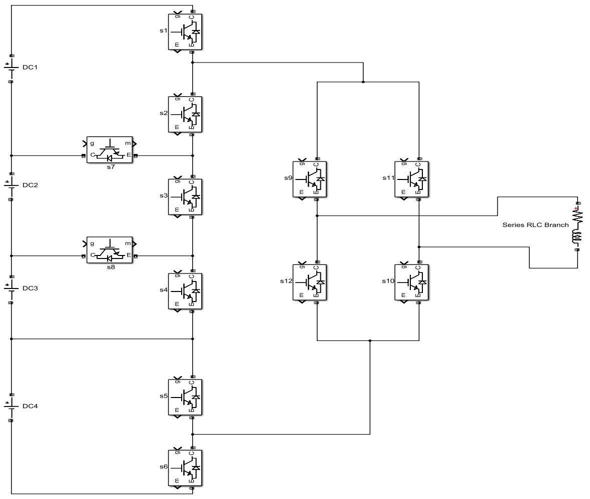


Fig.3 nine level inverter

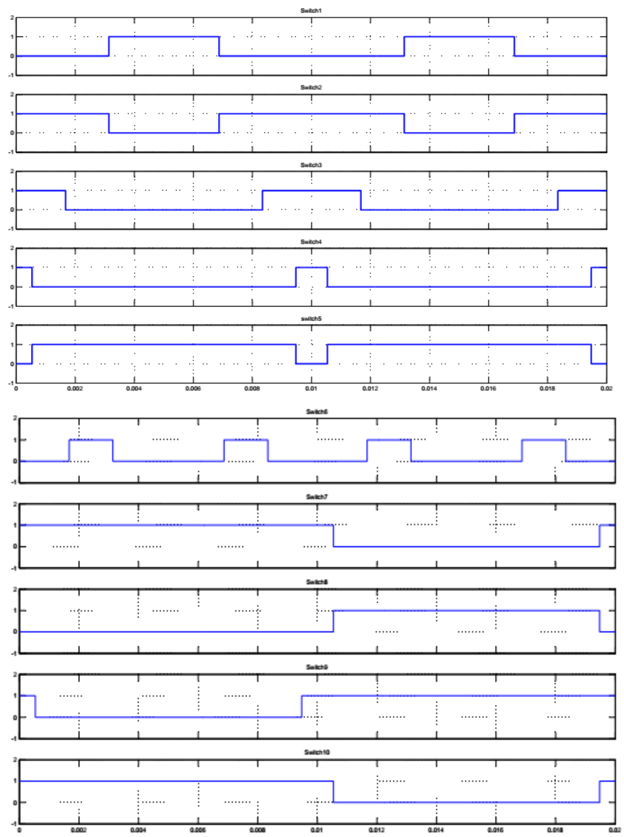


Fig.4 Switching pulses for multilevel inverter

III. SIMULATION OF PROPOSED MULTI LEVEL INVERTER FOR DIFFERENT LEVEL FED TO INDUCTION MOTOR :

Voltage source inverters (VSI) together with induction motors are being used ever more frequently as drive units in various fields. In particular they are frequently used in controlling the drives which improves the static and dynamic properties of the drive. The widespread implementation of the variable speed drives is also challenging designers and users to investigate the steady state and transient operating conditions of these drives. Computer-aided analysis and synthesis packages such as MATLAB/SIMULINK have been used in power electronics.

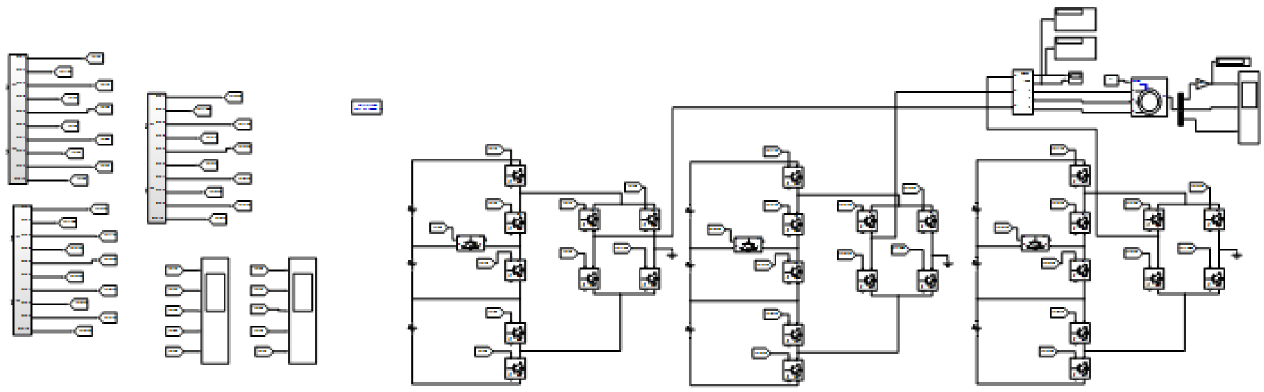


Fig.5 Three phase inverter fed to induction motor drive

In developing countries like India wind power in combination with solar power can play more substantial role to dramatically improve the lifestyle of people in remote areas. Many people live in isolated areas far from the main utility grid. In such remote or isolated areas since the cost of conventional energy resources are increasing every year in this system is going to be economical in future. Besides the cost the environmental benefits are likely to facilitate the widespread use and acceptance of this system. Thus the above proposed system is reliable and economical for remote applications.

The inverter is connected to the induction motor, three phase induction motor can be successful driven and from a fixed frequency and power supply by using a inverter, the motor speed can be easily adjusted. The inverter with induction motor is maximum available steady-state and dynamic torque must be taken into considerations.

The main advantages of using multilevel converters

For induction motor in large electric drives include the Following:

1) They are suitable for large volt-ampere-rated and/or high voltage motor drives.
2) These multilevel converter systems have higher efficiency because the devices can be switched at minimum frequency.
3) No EMI trouble or common-mode voltage/current problem exists.
4) No charge instability problem results when the converters are in either charge mode (rectification) or drive mode (inversion).

NUMBER OF COMPONENTS FOR THREE-PHASE INVERTERS

Inverter type	NPC	Flying capacitor	Cascade
Main switches	6(N-1)	6(N-1)	6(N-1)
main diodes	6(N-1)	6(N-1)	6(N-1)
Clamping diodes	3(N-1)(N-2)	0	0
DC bus capacitors/ Isolated supplies	(N-1)	(N-1)	3(N-1)/2
Flying capacitors	0	$\frac{3}{2}$(N-1)(N-2)	0
Total numbers	(N-1)(3N+7)	$\frac{1}{2}$(N-1)(3N+20)	$\frac{27}{2}$(N-1)

Table 2 number of components for three phase inverter

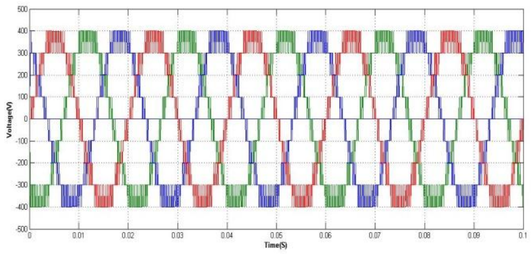


Fig 4.20 Simulation Result Three Phase In Motor Voltage Waveform

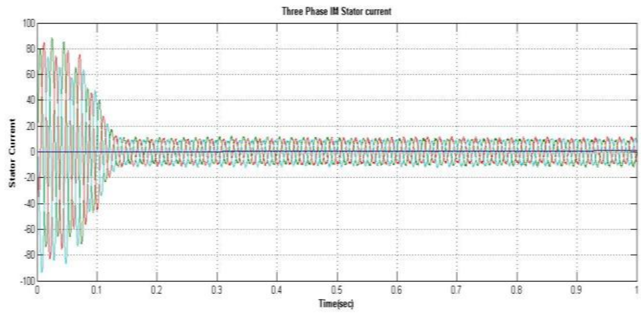


Fig 4.21 Simulation Result Three Phase In Motor Current Waveform.

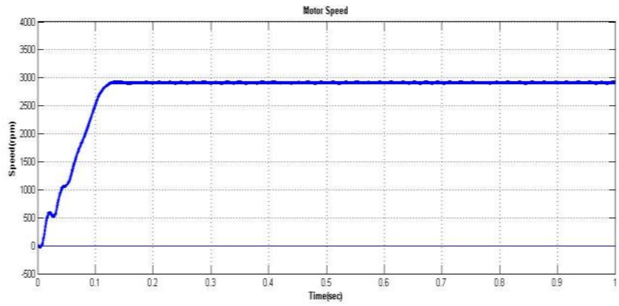
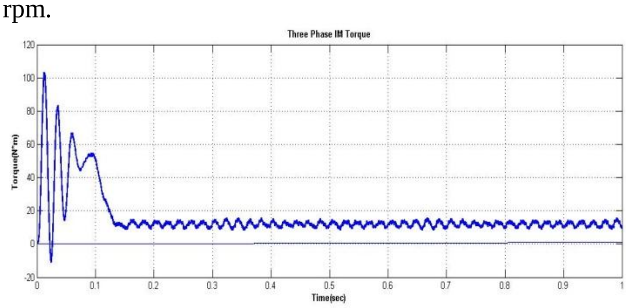


Fig 4.22 Simulation Result Speed Characteristics of Three Phase Induction Motor.

The below figure shows the speed characteristics of the induction motor drive motor is designed to run at 2900 rpm.



(B) Fig 4.23 Simulation Result Torque Characterstics of Three Phase Induction Motor.

Parameters	Value
Voltage	440 Volt
Frequency	50Hz
No. of Poles	2
Speed	2900 rad/sec

Table 4.1 System Parameter Induction Motor

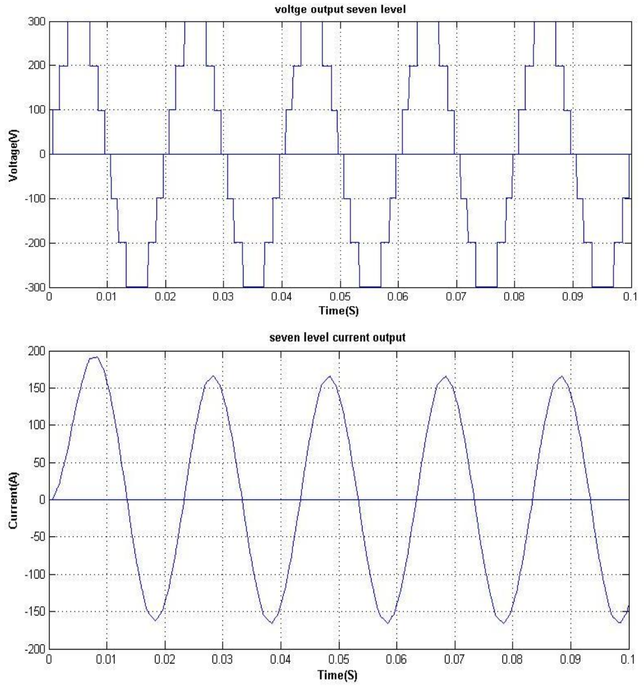


Fig 4.12 Output Voltage and Current Waveform result of seven level MLI.

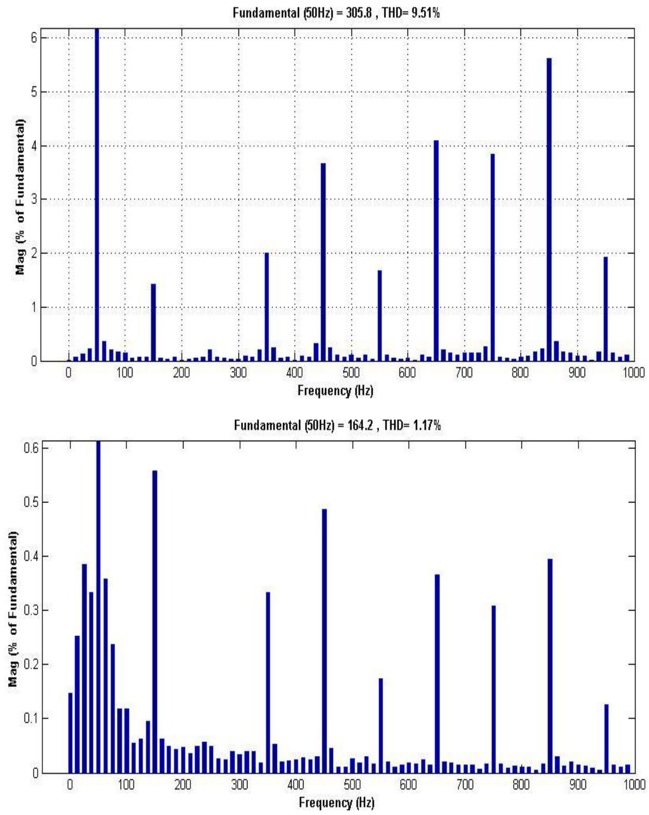


Fig 4.13 FFT of Voltage and Current resultof seven level MLI.

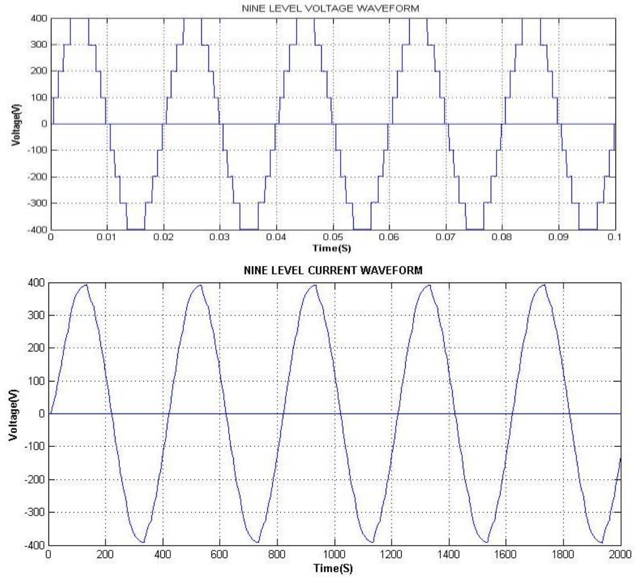


Fig 4.14 Output Voltage and Current Waveform result of nine level MLI.

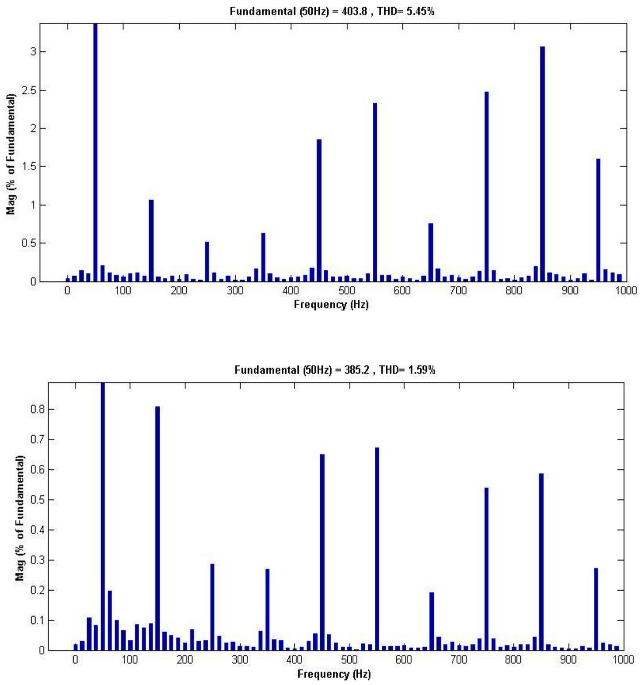


Fig 4.15 FFT of Voltage and Current result of nine level MLI.

IV. CONCLUSION

In this paper seven level cascaded H-bridge multilevel inverter is used to get Sinusoidal stepped output waveform and this also reduces harmonics in output voltage.The basic structure details and operating characteristics of cascaded multilevel inverter have been described by taking a seven-level inverter configuration. seven level and nine level inverters have been fed to three phase induction motor and speed torquecharacteristics have been showed.the total harmonic distortion have been reduced and efficiency of circuit has been improved.PWM technique is used to control the power switches of the inverter and extend the design flexibility and reduce the harmonics. The proposed control scheme have been verified analytically and demonstrated through matlab simulation.

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