Modeling And Simulation Of Highly Advanced Multilevel Inverter For Speed Control Of Induction Motor

Ravi Raj, Sunnivesh Suman

Abstract: In this Paper, the problem of removing Power dissipation from single phase Induction Motor with DC sources is considered by the speed control of Induction Motor with highly advanced 9-Level multi-level Inverter which having approximate zero Harmonics. As the demand of power is increasing day by day. So that, we must introduced very advanced Electrical Instruments which having high efficiency and less dissipation of power. The requirement of very advanced Inverter is necessary. Here we are designing a Multi-level Inverter up to the 9-level using IGBT (Insulated-gate bipolar transistor) by Mat lab which having negligible total harmonic distortion (THD) that's why it will control the speed of single phase Induction motor which is presently widely used in our daily needs. Also, several informative Simulation results verify the authority and truthiness of the proposed Model.

Key Words: DC Sources, Inverter, IGBT, THD, 9-Level diode add Inverter, Principle of single phase Induction Motor and Simulation Model.

1. Introduction

In recent time, Multi-level inverters are widely used as static power converter for very high power operation such as FACTS devices, HVDC light transmission and AC drives. One of the powerful advantages of multi-level modeling is the Harmonic minimizing in the output waveform without decreasing the inverter power output and controlling the speed of single phase Induction motor for less dissipation of electrical energy. The simulation output voltage waveform of a multi-level inverter is made of a number of levels of voltages, typically obtained from capacitor voltage sources. Thus Inverter is known as multi-level Inverter starts from 3- levels and as the number of levels of Inverter increases, the total harmonic distortion (THD) decreases. The most efficient and accurate multi-level Inverter is 9-level multi-level Inverter which having lowest total harmonic distortion (THD) among all multi-level Inverter. Here ,the technique of 9-level diode add and modulation of principle are introduced to control the output waveform as look as Sine Wave as close as possible. Thus 9-level multi-level Inverter is used as speed controlling of single phase Induction motor. Controlling approach of voltage and frequency supplied to stator coil is used as control the motor speed efficiently.

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2. DC-Sources

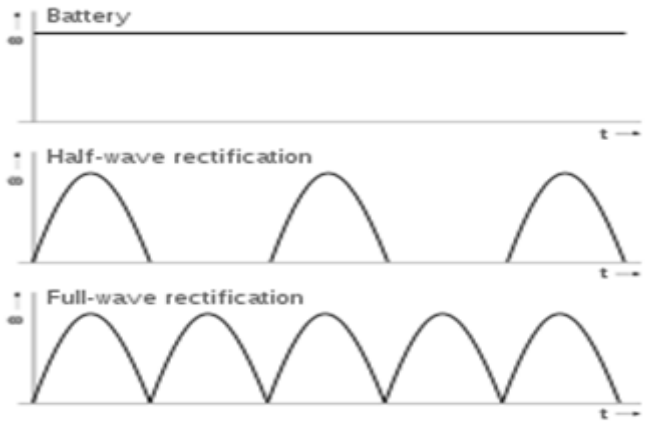

Fig :(1) *DC-Wave form*

The horizontal axis measures time; the vertical, current or voltage in Fig-(1). **Direct current** (**DC**) is the unidirectional flow of electric charge. **Direct current** is produced by **sources** such as batteries, power supplies, thermocouples, solar cells, or dynamos.

3. Inverter

An Inverter is an electronics device or circuit which change Direct current (DC) into Alternating current (AC). The input voltage output voltage, Frequency and total Power depends upon design and circuitry of Inverter. The Inverter only change DC to AC, it does not produce or generate Power . An inverter can produce a square wave, modified sine wave, pulsed sine wave, pulse width modulated wave (PWM) or sine wave depending on circuit design.There are mainly three types of Inverter are developed in which 9-level multi-level inverter is more effective.

4. IGBT

An insulated-gate bipolar transistor (IGBT) is a three terminal power semiconductor device which widely use as electronics switch. Its having high efficiency and fast switching property. That's why IGBT used as switch in various modern electrical appliances like Variable-

frequency drives (VFD),Air-conditioners, Trains, Refrigerators and Electric cars etc. The below Fig: (2) represents the internal cross-section Of IGBT.

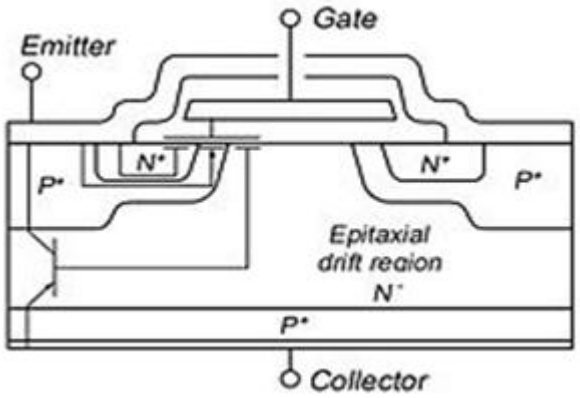

Fig: (2) *Cross-Section of IGBT*

5. THD

Total harmonic distortion (THD) is the ratio of summation of all harmonic components of the voltage or current waveform to the fundamental component of the voltage or current wave:

$$THD = \frac{\sqrt{(V_2^2 + V_3^2 + V_4^2 + \cdots + V_n^2)}}{V_1} * 100\%$$

THD or total harmonic distortion is the disturbance in the output wave form. Total harmonic distortion measures how muchof a Wave form power is distortion caused by Harmonics. The Total harmonic distortion measures the non-linearity of system, while applying a single sinusoidal to it. The total harmonic distortion in any Inverter can be represents by the following Fig: (3) (a) and (b).

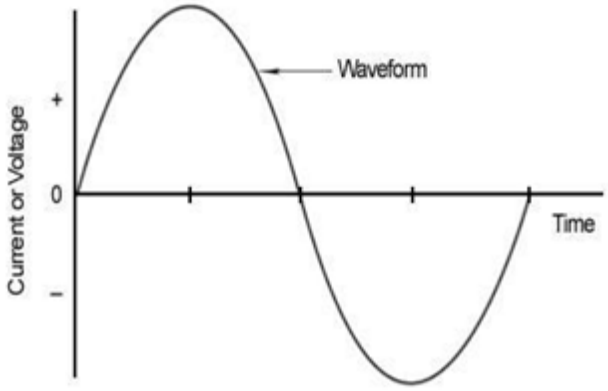

Fig: (3) (a) *Original Sine Wave*

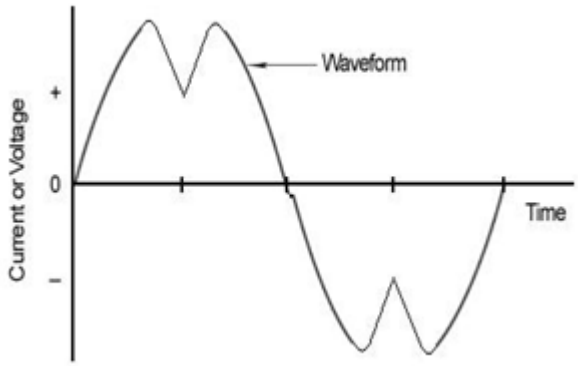

Fig: (3) (b) *Distorted Sine Wave*

6. Structure of 9-Level Diode add Inverter

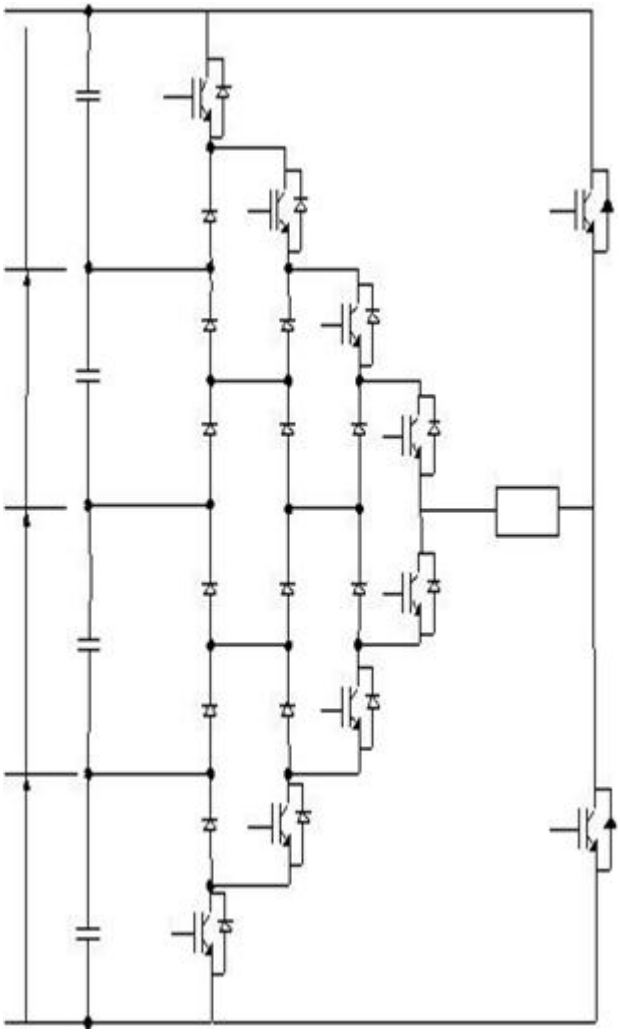

Fig: (4) *Structure of 9-Level add diode Inverter*

7. Single Phase Induction Motor for Speed Control with 9-Level Inverter

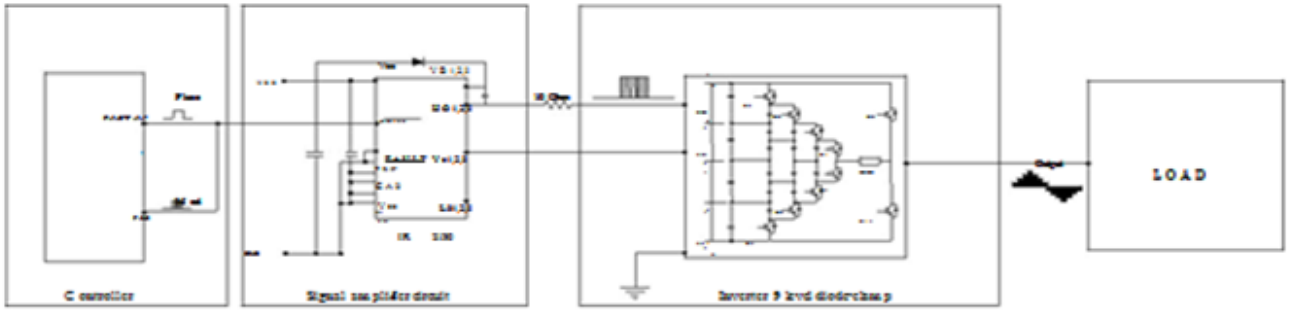

Fig:(5) *Single Phase Induction Motor with 9-level Inverter and Controller*

8. Simulation Model of diode add 9-Level Inverter for Speed Controlling of Single Phase Induction Motor

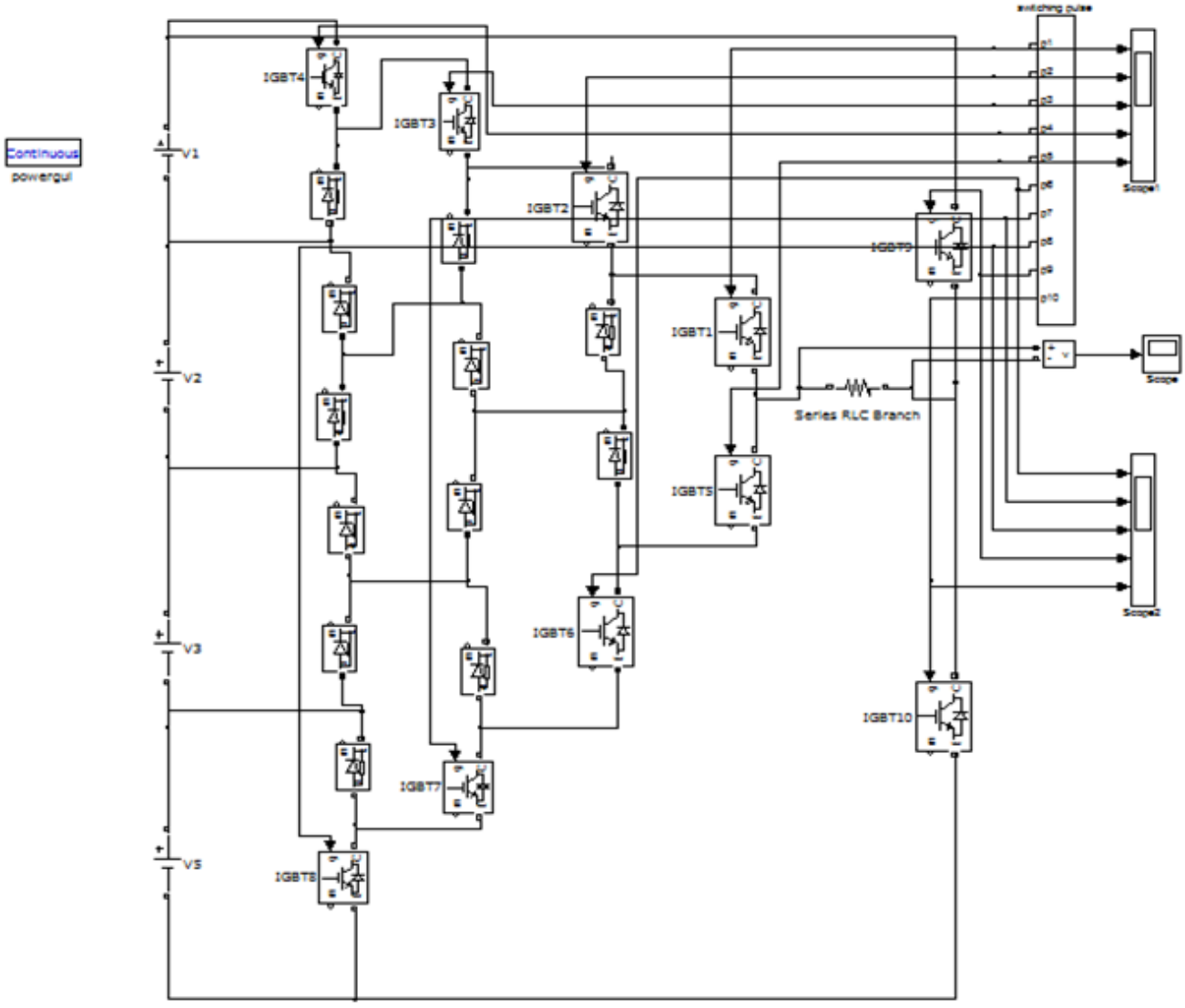

Fig:(6) *Simulation Model*

8. Experimental Result

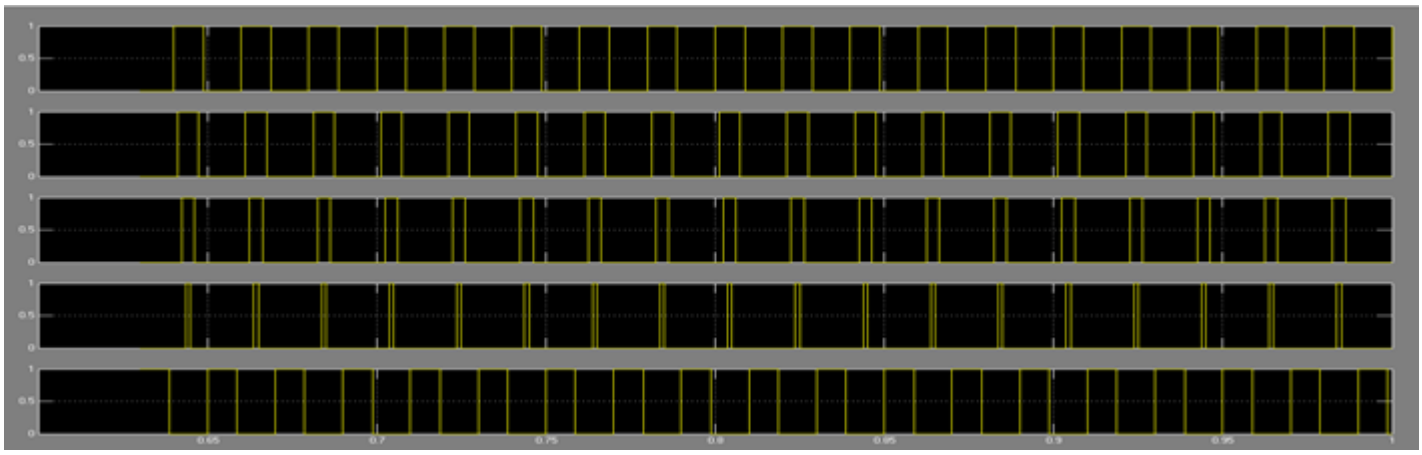

Fig:(6) *Simulation Result Scope-1*

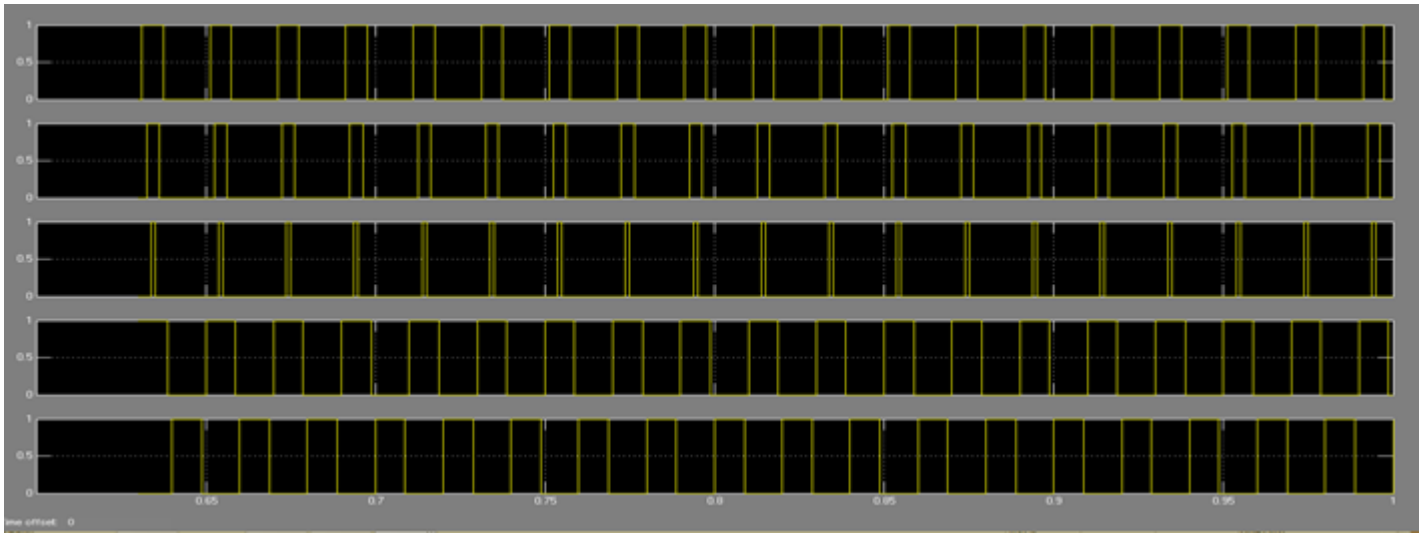

Fig:(7) *Simulation Result Scope-2*

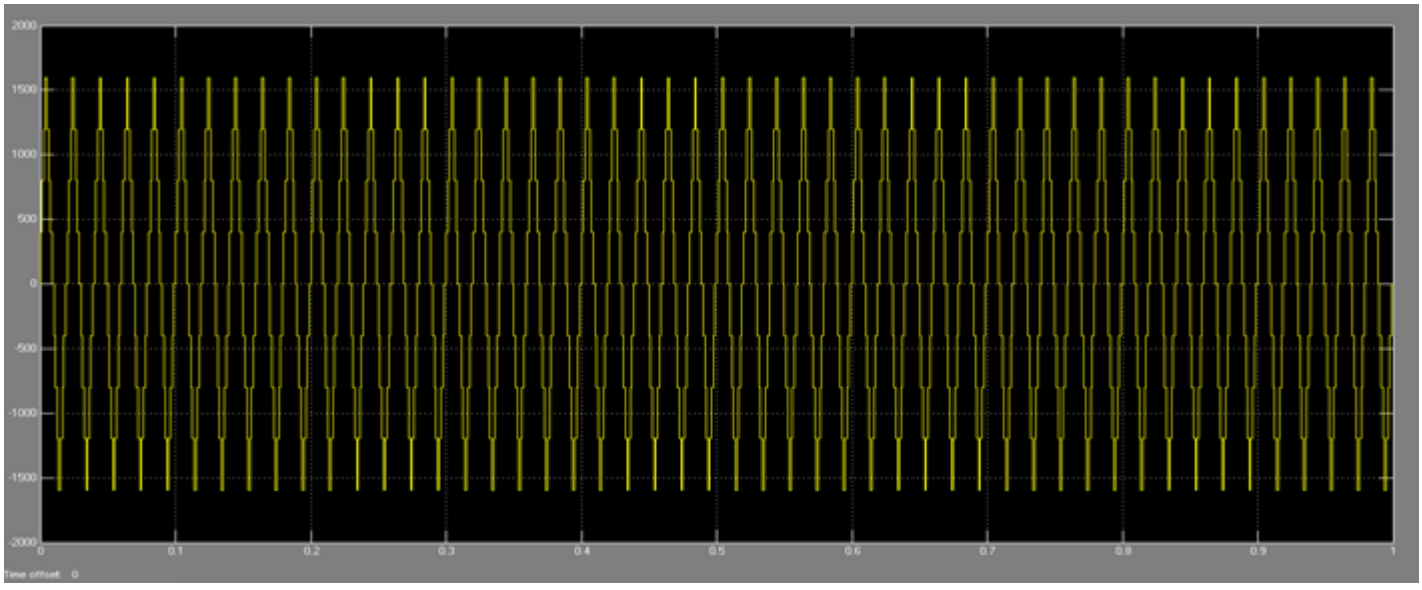

Fig:(8) *Simulation Scope Final Result (looking like Sinusoidal Wave Form)*

Table-1 *Important Elements*

Sr. No.	Parameters	Value
1.	Ideal DC Voltage Source in Voltage	400
2.	Series RLC Branch(Only Resistance) in Ohms	10

Table-2 *Diode*

Sr. No.	Parameters	Value
1.	Resistance(Ron) in Ohms	0.001
2.	Inductance(Lon) in H	0
3.	Forward Voltage(Vf) in Voltage	0.8
4.	Initial Current(Ic) in Ampere	0
5.	Snubber Resistance(Rs) in Ohms	500
6.	Snubber Capacitance(Cs) in F	250e-9

Table-3 *IGBT*

Sr. No.	Parameters	Value
1.	Internal Resistance(Ron) in Ohms	1-e3
2.	Snubber Resistance(Rs) in Ohms	1-e5
3.	Snubber Capacitance(Cs) in Farad	Infinite

From above simulation result, it is clear that the harmonics is minimized and resultant waveform looks like sinusoidal waveform which indicates that the controlling the speed of single phase induction motor happened with minimum THD. When this experiment was happened we have taken principally 9-level, diode add Inverter with 400V, 1/3 HP, 50 Hz motor. During this experiment, the controlling if voltage/ frequency have done for the controlling the speed of single phase induction motor by using 9-level multi-level inverter. Finally we are getting controlled signal phase induction motor which consumes very less power with respect to other single phase induction motor because here less distortions are occurring due to controlled speed with no energy dissipation.

9. CONCLUSION

From the simulation, the waveform of voltage signal of the 9-level diode add inverter is looks like to the sine wave. Result from the simulation of 1k ohms load and 1/3 HP, single phase induction motor load is found that control of the speed of induction motor is controlling frequency and adding to the pulse modulation signal way can reduce the voltage. The surge of current, and the starting torque. the technique of frequency control and modulation provides first steady state result while the speed is converting at maximum load and it is clear that the THD values of 9-level inverter is very low which is suitable to speed control of induction motor.

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