Unipolar and Bipolar PWM Inverter Fed Induction Motor Drive

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Abstract— Sinusoidal pulse width modulation or SPWM is widely used in power electronics. To digitize the power so that a sequence of voltage pulses is generated by ON or OFF of the power switches the pulse width modulation inverter has been the main alternative in power electronic for many years as a result of its circuit simplicity and rugged control scheme SPWM switching technique utilized in used in industrial applications SPWM techniques are characterized by constant amplitude pulses is completely different duty cycle for each period the width of this pulses are modulated to obtain inverter output voltage control to diminished its harmonic content ,Sinusoidal pulse width modulation or SPWM is that technique to used in motor control and Inverter application in this thesis development a unipolar and bipolar SPWM voltage modulation type is given as a result of this method offers the advantage of effectively doubling the changed frequency of the Inverter voltage making the output filter smaller cheaper and easier to generate with this signal triangle wave as a carrier signal is compared to the sinusoidal wave whose frequency is the desired frequency. In this thesis single-phase inverters and their in operation principles are analyzed very well the concept of sinusoidal Pulse Width Modulation or PWM for inverters is explain with analyses extended to different kinds of SPWM strategies.

Key words: Unipolar, Bipolar, Inverter, Over PWM Modulation, Induction Motor drive

I. INTRODUCTION

An inverter is basically a device that converts electrical energy of DC form into that of AC. The aim of DC-AC inverter is to require DC power from a source and converts it to AC.

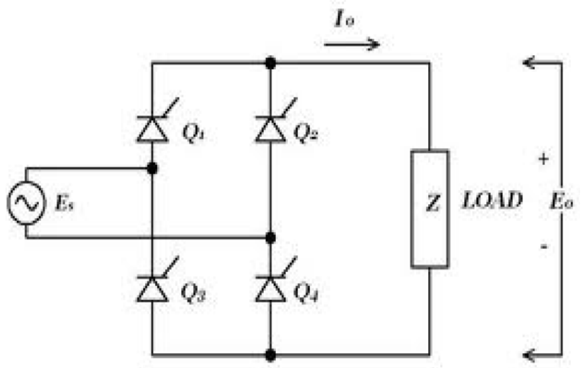

Fig. 1: Voltage source inverter

As shown in figure 1 the semiconductor switches Q_1, Q_2,Q_3 and Q_4 are connected.

- When Q1 and Q4 are turned on +Vs is obtained at the output.
- When Q2nand Q3 are turned on –Vs is obtained at the output.
- When Q1 and Q2 or Q3 and Q4 are turned on together zero voltage is obtained at the output.

II. PWM TECHNIQUES

Pulse-width modulation (PWM) is the basis for control in power electronics theoretically zero rise and fall time of an ideal PWM waveform offer a most popular way of driving modern semiconductor power devices. The exception of resonant converters the vast majority of power electronic circuits. They controlled by PWM signals of various forms the fast rising and falling edges ensure that the semiconductor power devices. The turned ON or OFF as quick as practically probable to minimise the switching transition time. The upper limit on the turn-ON or OFF speed in practical situations the resulting finite rise and fall time can be ignored in the analysis of PWM signals

A. *SPWM with Bipolar Voltage Switching*

The sampling of SPWM bipolar switching is as shown in figure 2 in that the reference voltage waveform having magnitude V_r are compare with carrier signal having amplitude V_c sinusoidal waveform is used as reference signal and triangular waveform as carrier signal as shown in figure 3.

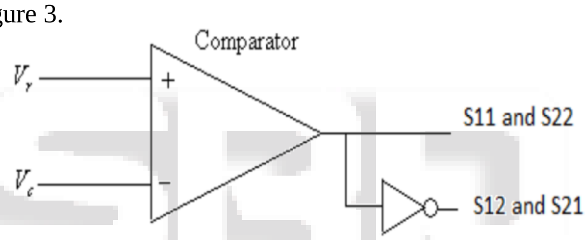

Fig. 2: Bipolar Switching

In this technique al switch are on at same time and the output voltage magnitude depends on V_r and V_c.

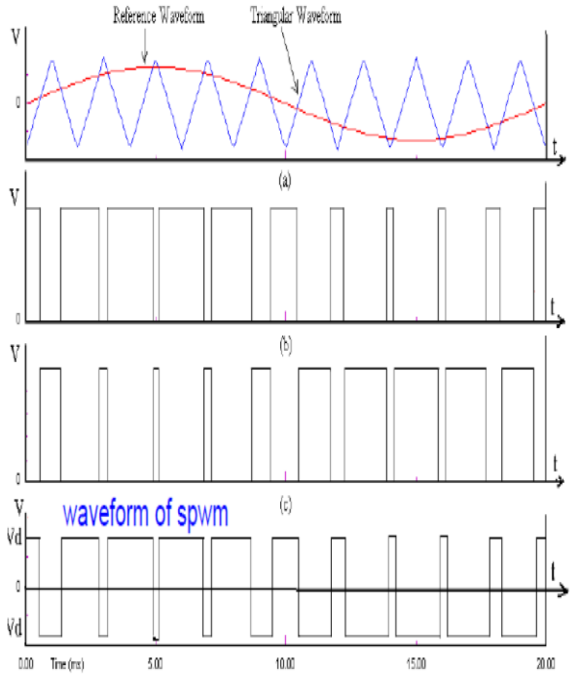

Fig. 3: Waveform of bipolar switching pulse

In this technique two power switch(S_{11} and S_{21}) are on at same time in single phase full bridge inverter with other two(S_{12} and S_{22}) are remain in OFF state condition in next state S_{12} and S_{22} are ON and S_{11} and S_{21} are OFF state condition. The output waveforms are as shown in figure 3.6.

B. SPWM with Unipolar Voltage Switching

In this technology one carrier signal is compare with two reference signal in which one of them is positive and other one is negative signal the basic idea of Unipolar switching is shown in figure 4 the basic of Unipolar switching is as shown in figure 5 the switching output waveform are as shown in figure 3.8. The output voltage in Unipolar switching is vary within a limit of 0 to Vdc and if the switching frequency is increase in that case the harmonic level is raise and frequency increase with load so the harmonic level is low as compared to Bipolar switching.
This technology power switch is turn ON or OFF according to the comparison of two reference and carrier signal as shown in figure 4

In this technology output voltage is varies within a 0 to +Vdc or 0 to -Vdc so the switching frequency is twise and the harmonic level is reduce.
The output signal is as shown in figure 5

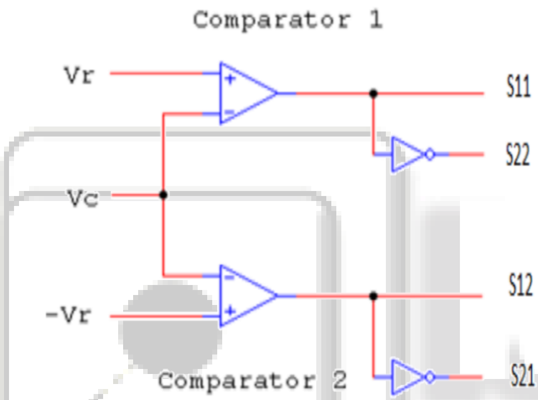

Fig. 4: Unipolar SPWM generator

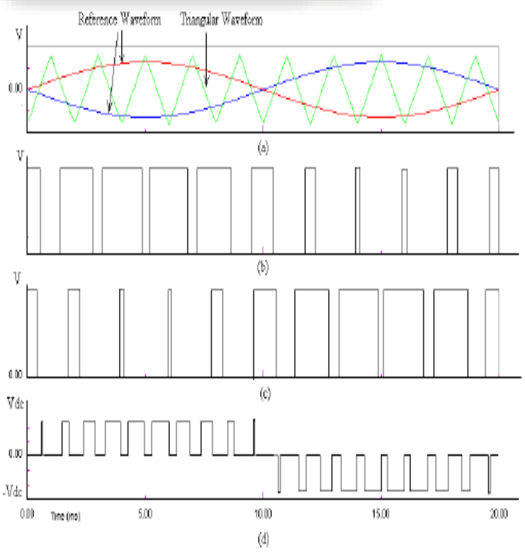

Fig. 5: Unipolar switching signal Waveform

III. BIPOLAR PWM INVERTER

The upper and the lower switches in the same inverter leg work in a corresponding manner with one switch turned on and other turned off. Thus we need to consider only two independent gating signals V_{g1} and V_{g3} they are generated by comparing sinusoidal modulating wave V_m and triangular carrier wave V_{cr}.

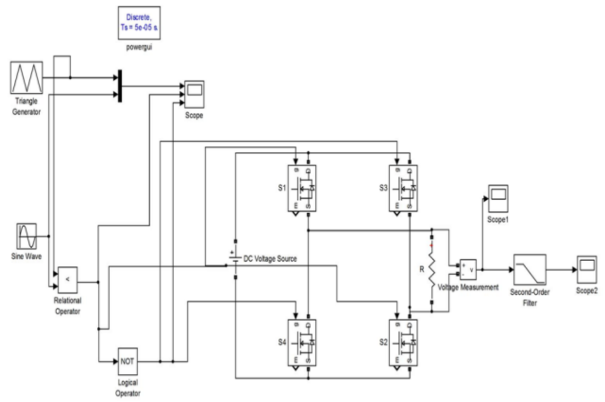

Fig. 6: Simulink modal of Bipolar PWM inverter

IV. UNIPOLAR PWM INVERTER

The unipolar modulation normally requires two sinusoidal modulating waves V_m and V_{m-} which are of same magnitude and frequency but 180^0 out of phase. The two modulating wave are compared through a common triangular carrier wave V_{cr} generating two gating signals V_{g1} and V_{g3} for the upper two switches S_1 and S_3 can be observed that the upper two devices do not switch simultaneously, which is well-known from the bipolar PWM where all the four devices are switched at the same time. The inverter output voltage switches either between zero and $+V_d$ during positive half cycle or between zero and $–V_d$ during negative half cycle of the fundamental frequency this is called unipolar modulation.

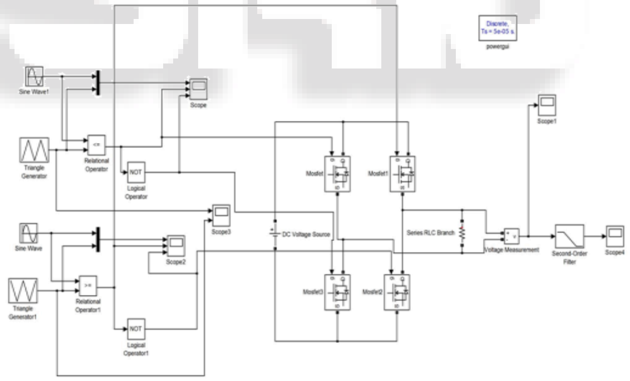

Fig. 7: Simulink modal of Unipolar PWM inverter

V. BLOCK MODEL OF PWM INVERTER FED THREE PHASE INDUCTION MOTOR

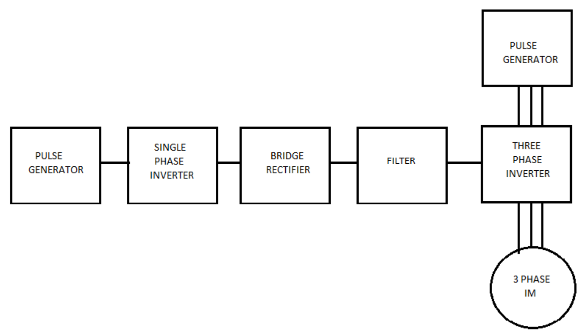

Fig. 8: Block diagram of PWM inverter fed three phase Induction motor

A. *Pulse Generator*

The first block is used as pulse generator where we have use the PWM techniques in this we have used the unipolar and bipolar switching techniques.

B. *Single Phase Inverter*

In this block we have drawn the single phase inverter and the switch we in the inverter circuit is the MOSFET switches and the gate pulse which is given to it is the PWM switching technique and the output of inverter is to be taken.

C. *Bridge Rectifier*

In this block we can convert the output of single phase inverter which is AC and the bridge rectifiers will converter it to DC.

D. *Filter*

The some of ripples which is in DC will be eliminated and the desired DC will get from this block.

E. *Three Phase Inverter*

The output of filters has been given to this block the given filtered DC is converted into AC. As PWM generator pulse is given to it which is 12 pulse these 12 pulse is given as a gate pulse of a three phase inverter.

F. *Three Phase Induction Motor*

The output of three phase inverter block is given to induction motor the internal block of induction motor is taken it from the Simulink library and the desired internal parameter are given to it for the outcome of the induction motor.

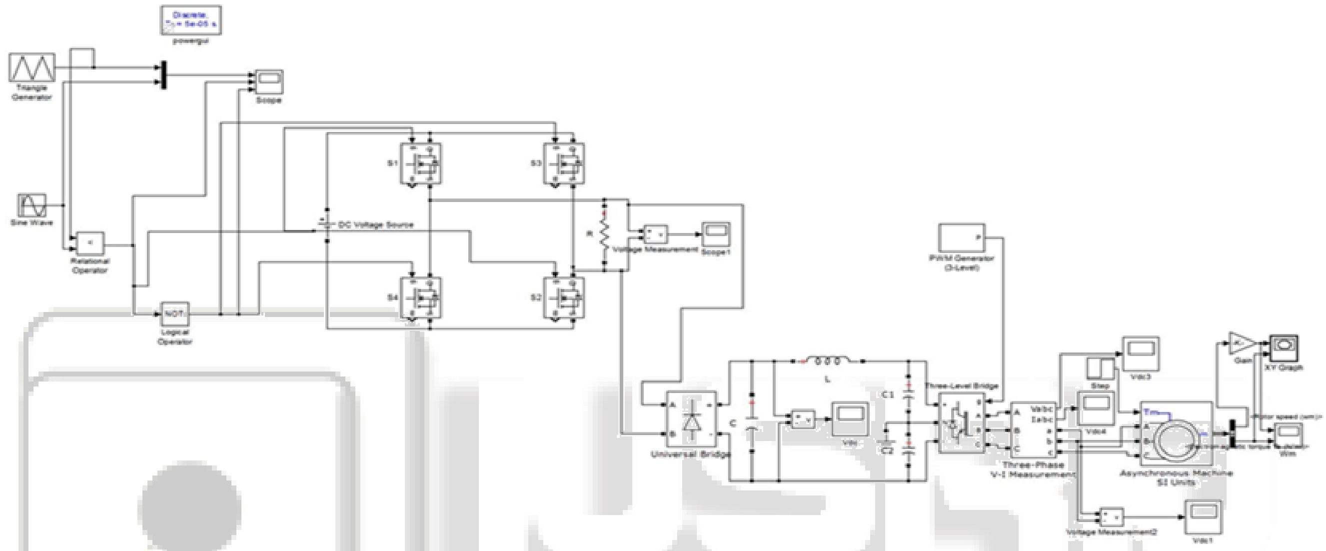

Fig. 9: Bipolar PWM inverter fed Three Phase induction

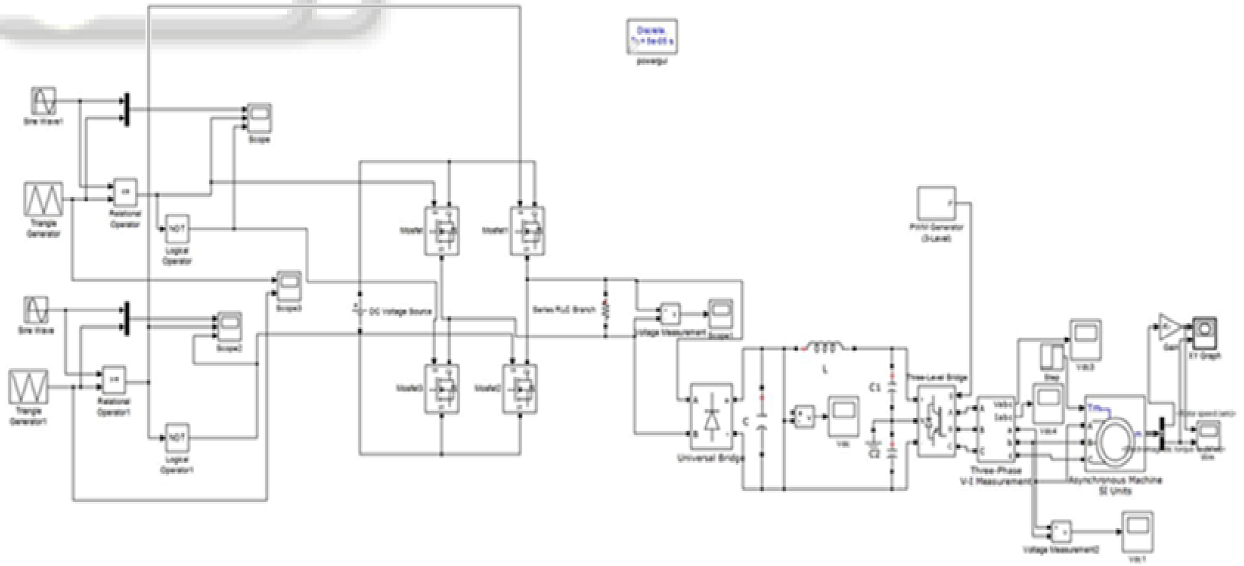

Fig. 10: Bipolar PWM inverter fed Three Phase induction Motor

VI. RESULT AND DISCUSSION

A. *Bipolar PWM inverter*

The following waveform is the output of fig :-6 simulink modal of bipolar PWM inverter the AC output is take in the form of square waveform whose peak amplitude is nearly 220V.

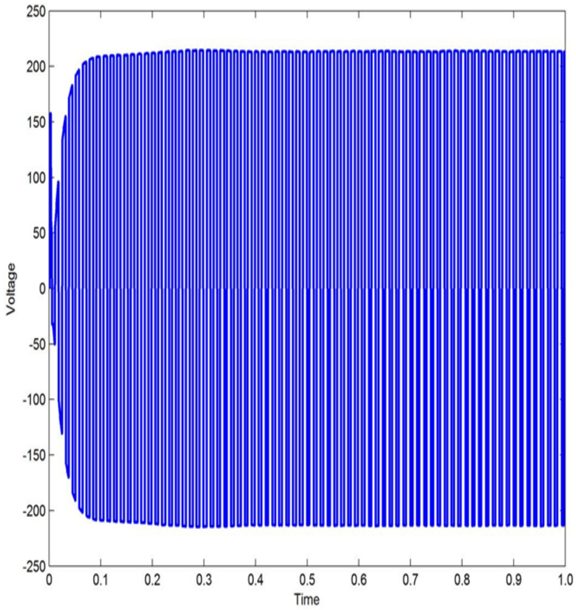

Fig. 11: Simulated result of output waveform of Bipolar PWM inverter

B. Unipolar PWM Inverter

The shown waveform of fig :-7 simulink modal of unipolar PWM inverter here also a AC voltage waveform is come as a output result but the output waveform of unipolar PWM inverter is better than the output waveform of bipolar PWM inveter and the peak amplitude of waveform is nearly 220V.

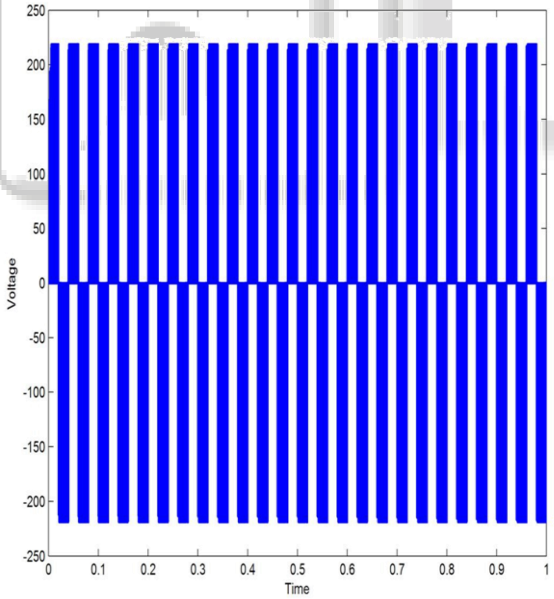

Fig. 12: Simulated result of output waveform of Unipolar PWM inverter

C. Bipolar PWM Inverter Fed Three Phase Induction Motor

The output waveform is a result of fig 9 in which the speed-time graph is showm

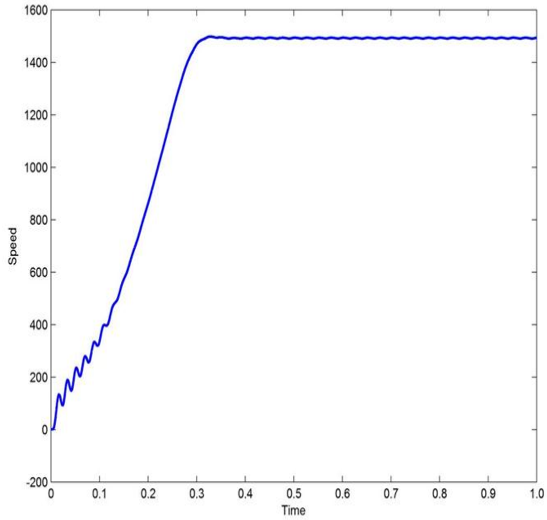

Fig. 14: Simulated result of speed time curve of bipolar PWM inverter fed three phase induction motor

In this graph the torque-time waveform is shown of fig 9.

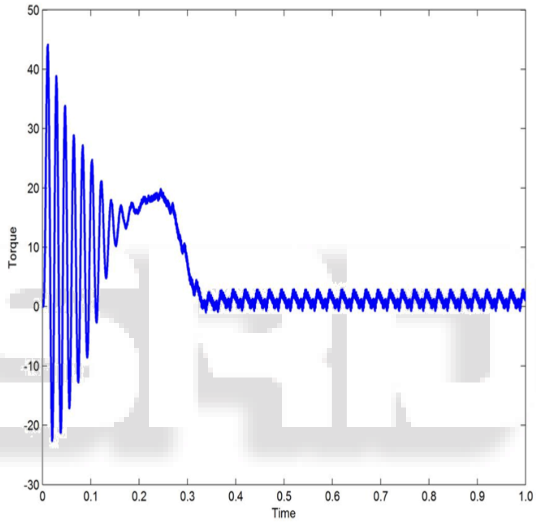

Fig. 13: Simulated result of torque-time curve of bipolar PWM inverter fed three phase induction motor

D. Unipolar PWM Inverter Fed Three Phase Induction Motor

In the below graph the output of fig 10 as shown with the speed-time characteristic.

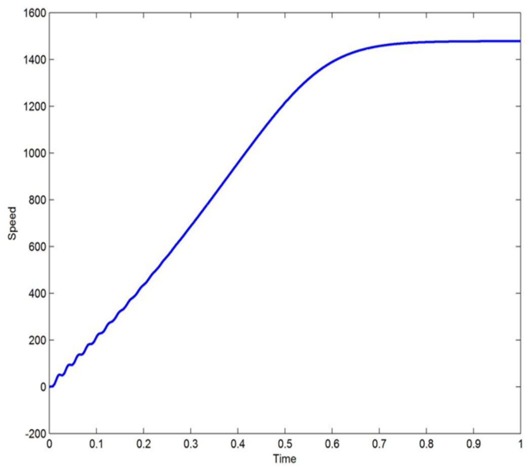

Fig. 15: Simulated result of speed time curve of unipolar PWM inverter fed three phase induction motor

The resulted curve shows the waveform of torque-time characteristic of fig 10

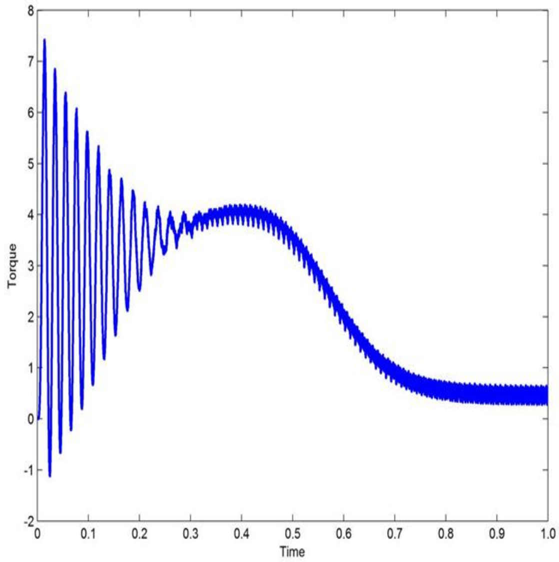

Fig. 16: Simulated result of torque-time curve of unipolar PWM inverter fed three phase induction motor

VII. Conclusion

The bipolar PWM inverter is it consists of two units the generator unit and control unit. The generator unit produces a PWM waveform by comparing the triangular and sinusoidal to one another. The control unit creates the bipolar switching and due to the simplicity the control unit uses a half bridge topology. To prove that the inverter works, we verified the input and output waveforms of each unit. On the generator unit, we were able to obtain a 50Hz sinusoidal control signal, 15 kHz triangular carrier signal and a pulse width modulated square output signal

The SPWM with Unipolar voltage switching scheme has better harmonic profile compare to Bipolar voltage switching because of that SPWM with Unipolar voltage switching will use as a switching scheme for the single phase inverter.

With an Unipolar and bipolar PWM inverter an induction motor is also be run and the characteristic curve of speed torque wave form curve is also be simplified

VIII. Future scope

This thesis performs a systematic analysis of PWM control schemes for single phase full-bridge DC-AC converter topology given in future

- The different types of PWM techniques were used and order to further reduce harmonic content of the output voltage and current, various multi-levels DC-AC converter topologies are proposed and analyzed in recent years.
- These multi-level topologies are basically derivations from the two level topology by adding additional IGBT power switches to the bridge circuit.
- PWM control techniques are still the most popular and efficient method for multi-level power conversion of theoretical and simulation approaches used in this thesis can be extended for PWM scheme studies for multi-level applications and it is reported that with the increase of converter topology levels, the system harmonic distortion will be reduced accordingly under the same carrier frequency.
- As a tradeoff, the complexity of circuit topology and PWM scheme will increase. For the future research works are recommended to explore advanced solutions with increased performance, reliability and robustness, while reducing the control complexity and cost.

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