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Three Phase Inverter Simulation using Transistor (IGBT) and Thyristor(GTO) Technique

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ABSTRACT: There are many inverter topologies in which cascaded inverter have some advantages compared to other multilevel inverters such as reduced harmonics but they have drawbacks also such as many heat losses, more switches, high cost. But in this new configuration which is developed in this project overcome all these disadvantages. In this project four different pulse width modulation techniques are used, they are In Phase disposition

I. INTRODUCTION

In today's world most of the appliances and machines work on AC power .In the absence of AC power, there should be some way to convert DC power to AC power. This conversion is done by the power electronic circuit called the Inverter. The basic function of a power inverter is to change DC input voltage to a symmetric AC output voltage of the desired magnitude and frequency. These devices find wide applications in Uninterruptable Power Supplies (UPS), adjustable speed AC drives, induction heating and standby aircraft power supplies. If the DC input voltage is fixed but not controllable, a variable output voltage is obtained by varying the gain of the converter which is achieved by Pulse Width Modulation technique (PWM) control. The gain of the inverter is defined as the ratio of AC output voltage to that of DC input voltage.

There are two types of inverters-Voltage source and current source inverters. When an inverter has DC source with negligible resistance (which means that it has a stiff DC voltage source at its input terminals), it is said to be a voltage fed inverter or VSI. Whereas when it has a high input resistance (means it has a stiff DC current source at its input terminals), it is termed as current fed inverter or CSI.

II. PULSE WIDTH MODULATION (PWM)

In Pulse Width Modulation (PWM) technique, pulses of constant amplitude but different duty cycles are generated by modulating the time periods . This modulation is done by using one carrier and one reference signal .These two signals are fed to a comparator and the corresponding signals are generated based on the logic of the comparator. The reference wave is the desired signal output which may be a sine wave or a square wave.
Inductor a selected range of lower harmonics can be reduced by suitably choosing the number of pulses per half cycle.
Advantages of using PWM technique-

1. The output voltage can be controlled without using any additional component.
2. Significant reduction of lower order harmonics

There are three basic PWM techniques There are three basic PWM techniques-

1. Single pulse
2. Double pulse
3. Multiple pulse
4.

III. SINUSOIDAL PULSE WIDTH MODULATION (SPWM)

In Sinusoidal PWM, the width of each pulse is varied in proportion to the amplitude of the sine wave evaluated at the center of the same pulse. The gating signals are generated by comparing a sinusoidal reference wave with a triangular carrier wave of frequency Fr and Fc respectively as shown in Figure 1. Fr determines the inverter output frequency fo and its peak amplitude Ar controls the Modulation Ratio (Ar /Ac) and hence the r m s output voltage Vo. Several pulses per half cycle are used and the pulse width is a sinusoidal function of angular position of pulses in a cycle. A high frequency carrier wave Vc is compared to a reference signal Vr having the in Figure 1. Fr determines the inverter output frequency fo and its peak amplitude Arcontrols the

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Modulation Ratio (Ar /Ac) and hence the r m s output voltage Vo. Several pulses per half cycle are used and the pulse width is a sinusoidal function of angular position of pulses in a cycle. A high frequency carrier wave Vc is compared to a reference signal Vr having the desired frequency through a comparator. When the sinusoidal wave has a higher magnitude, output is high otherwise it is low. The comparator output is processed in a trigger pulse generator in such a way that the output voltage wave has a pulse width in agreement with comparator pulse width.

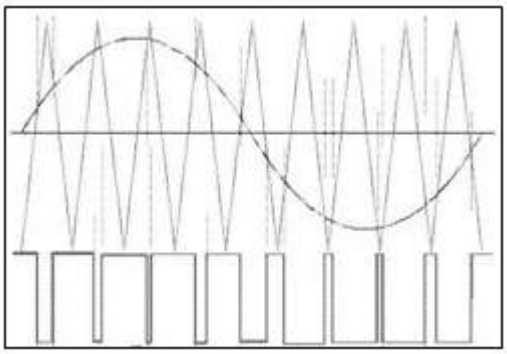

Fig [1] Sinusoidal PWM

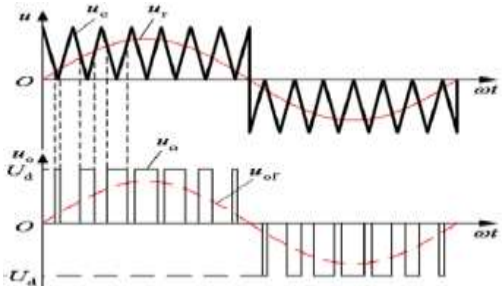

Fig 2[a].Unipolor

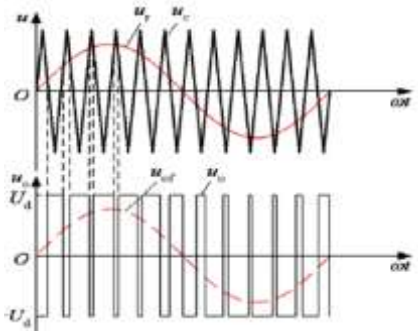

Fig2[b].Bipolor

IV. SWITCHING TECHNIQUES

To provide the gate signals to the switches in an inverter, two types of switching schemes are used-Unipolar and Bipolar voltage switching. If the triangular carrier wave is either in the positive or negative polarity range of changes, the resulting SPWM wave lies only in the polar Range, this type of switching is called unipolar control mode.

Whereas if the triangular carrier wave lies in continuous range between both positive and negative polarity, the SPWM wave lies between positive and negative changes, this switching is known as bipolar control.

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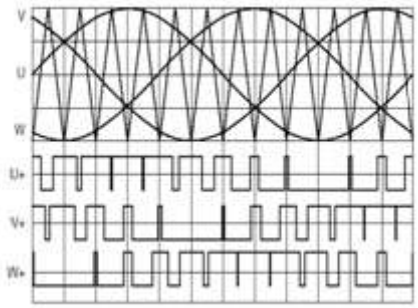

Fig.[5]Matlab/Simulink model of IGBT

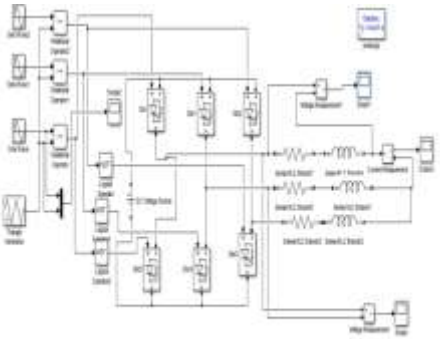

Fig.[6] Matlab/Simulink model of GTO

The gate pulses given to the three phase inverter are using GTO shown in Figure 6. The frequency of the carrier wave is kept 1000 Hz whereas for reference sine wave, it is 50 Hz

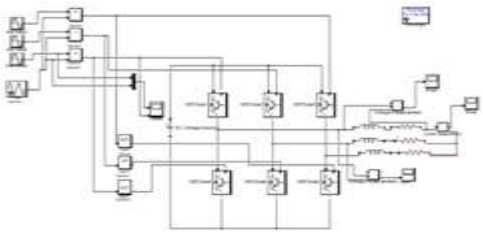

Fig.[3]The basic circuit diagram of a three phase inverter with 6 IGBTs is shown in Figure

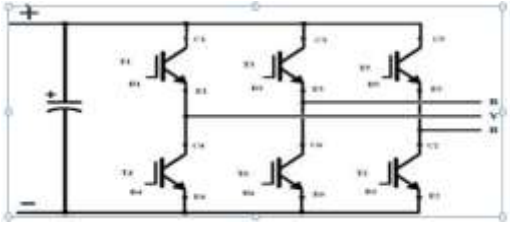

Fig.[4] Three phase inverter

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V. THREE PHASE INVERTERS

The three phase inverter is used to provide variable frequency power for industrial applications.

SPWM is used for the voltage control of three phase inverters and the corresponding gating signals are shown in Figure 3. Here, triangular carrier wave is compared with three referencesinusoidalwaves (U,V,W) which are displaced by 120 degrees.

The inverter is fed by a fixed dc voltage Vdc and has three phase-legs each comprising two IGBTs. With SPWM control, the switches of the inverter are controlled by comparing a sinusoidal signal and a triangular signal. The sinusoidal wave determines the desired fundamental frequency of the inverter output, while the triangular wave decides the switching frequency of the inverter. Each transistor conducts for 180 degrees. Three of the transistors conduct at a time inthe order 612,123,234,345 and so on. When T1 is switched on, terminal Y is connected to the positive terminal of the DC supply voltage. The output voltage (line and phase) is measured across the Y connected RL load. The matlab /Simulink model is shown in Figure . The DC input voltage is kept as 400 V. The load resistor and inductor values are chosen to be 2 ohm and6.5 MH.

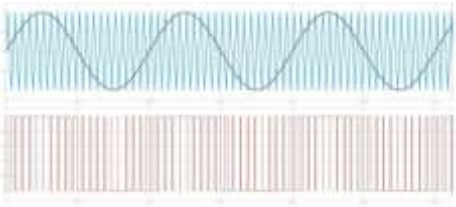

Fig 7.[a] Gate pulses for T1

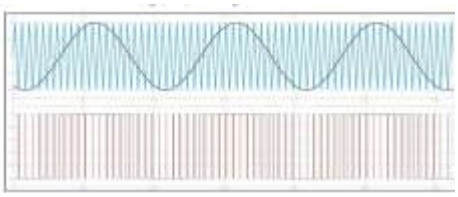

Fig 7.(b) Gate pulses for T1

VI. RESULTS

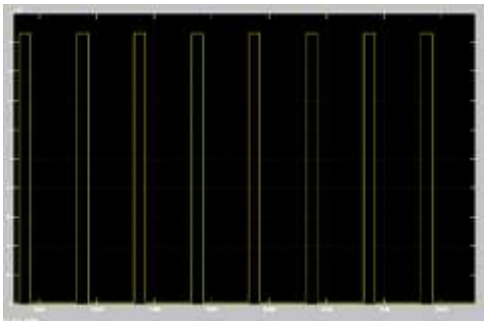

Fig 7[a] Phase voltage IGBT

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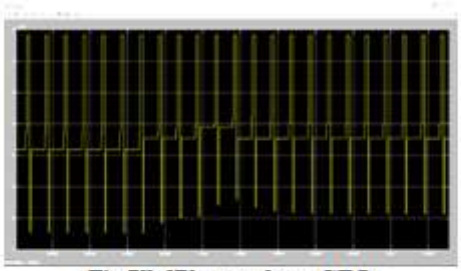

Fig 7[b]Phase voltage GTO

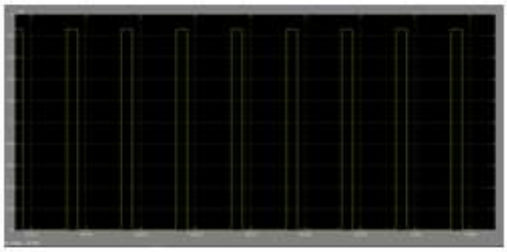

Fig. 8[a] Line Voltage of IGBT

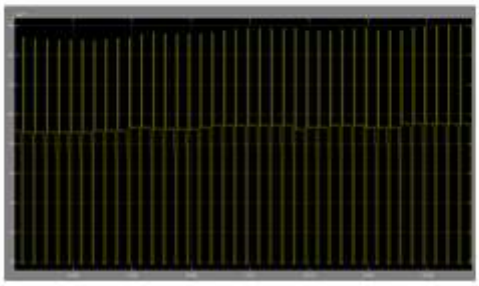

Fig 8[b].Line Voltage of GTO

VII. CONCLUSION

[1]. Sinusoidal Pulse Width Modulation is applied for switching the switches. The total harmonic distortion for different modulation index is calculated and compared for RL load. As it can be seen from the results that as the modulation index approach one, THD reduces significantly. SPWM technique is a common method used to provide gate signals to the switches in three phase inverter circuit.

[2]. The simulation of three phase inverters is carried out in MATLAB/Simulink where a simple control

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