Design of Three Phase PWM Voltage Source Inverter for Induction Heater

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Abstract: **Induction heating is a well-known technique to produce very high temperature for applications. In this paper presents the three phase DC-AC inverter mainly used in high power applications such as induction heating in industries . This technique has become one of the important PWM techniques for Three Phase Voltage Source Inverter (VSI) for the control of power. this model mainly consist of dc-ac converter.the three leg MOSFET operated inverter is constructed. The proposed control method is implemented in full bridge topology for application. This result in an increase of the net efficiency of the induction heating system .the simulation has been carried out by MATLAB.**

Keywords: **DC-AC converters, VSI, LC filter, three phase bridge converter, 3 legs MOSFET, Unbalanced load.**

I. INTRODUCTION

Inverters are used in a large number of power applications. Within the last decade, there have been major upgrading in power electronics. An Inverter is basically a converter that converts DC-AC power. The function of an inverter is to convert DC power to AC, these are offered to as Voltage Source Inverters (VSI). A voltage source inverter (VSI) is one that takes in a fixed voltage from a device, such as a dc power supply, and converts it to a variable-frequency AC supply. VSI are divided up into three categories: Pulse-width Modulated (PWM)Inverters, Square-wave Inverters, and Single-phase Inverters with Voltage Cancellation. This paper will talk about the Pulse-width Modulated inverter.

Pulse-width modulation inverters take in a constant dc voltage. The inverter should conduct the magnitude the frequency of ac output voltages, and the diode rectifiers are required to fix the line to line voltage. The inverter uses pulse-width modulation using it's switches, there are various methods for doing the pulse-width modulation in an inverter beneficial to frame the output ac voltages nearly similar to sine wave. The inverter only controls the frequency of the output where the input voltage controllers the magnitude. The ac output voltage get a waveform identical to a square wave to which the inverter got it's name. In ac-motor drives the switch-mode dc-to-ac inverters are applied and un interruptible supplies of ac power where the central equitable is to provide a sinusoidal ac output where magnitude and frequency the couple can be controlled. Micro-inverters converts direct current from individual solar panels on to alternating current for the electric grid, they are grid tied. The Photovoltaic inverter can be supplied into a profitable electrical grid or can be used in an off-grid. Photovoltaic inverters have positive functions fitted for the use with photovoltaic arrays, as well as anti-islanding protection and maximum power point tracking. An inverter converts the DC electricity to AC electricity from sources like fuel cells and batteries. The electricity required voltage, particularly it can keep AC equipment design for main operation and improved to yield DC at any crave voltage. In inverters the power semiconductors devices always remains forward-biased due to the supply voltage, and therefore, self controlled forward device such as IGBTs and MOSFETs are suitable.

II. THREE PHASE PWM INVERTER

In an inverter the output voltage can also be adapted by applying a controller itself in the inverter. The better method for powerful output this can be done by pulse width modulation control using itself interior of aninverter.

By implementing this method, a constant dc inputvoltage is disposed into the inverter. Also a unflappable ac output voltage is accessed by regulating the on and offduration of the inverter units. PWM techniques are represented by fixed amplitude pulses. This is the mostsuitable method of controlling the output voltage. This method is labelled as Pulse-Width Modulation (PWM)Control. The advantages enchanted by PWM techniques are mentioned as:[6][7] a) Without any other units in this method the output voltage can be controlled easily. b) With the controlling of the output voltage, lower order harmonics can be erased or minimized. The filtering elements are minused as higher order harmonics can be filtered calmly. The major disadvantage of PWM method is that SCRs are costly as they should carry low turn-on and turn-off times. PWM inverters are very much suitable in industrial applications. After the modulated to achieve the output voltage control of inverter and to minimise the harmonics present by the width of these pulses. The various PWM techniques are as following: a) Single-pulse modulation b) Multiple pulse modulation c) Sinusoidal pulse width modulation.

III. THE THREE PHASE VOLTAGE SOURCE INVERTER

The three phase voltage source inverter generates less harmonic distortion in the output voltage utilized in thephase to phase AC load. Also afford extra productive supply voltage related to sinusoidal modulation technique.
The circuit model of three-phase voltage source PWM inverter is shown in Fig.1. TA+, TA- ;TB+,TB-; to

TC+,TC- are the six power switches that model the output, which are controlled by the switching variables. When an upper transistor is switched on i.e., the corresponding TA-,TB-,TC- is 0. Therefore, the on and off states the upper transistors TA+, TB+, TC+, can be used to regulate the
output voltage. Each power switch can be on and off, On = 1, Off = 0.
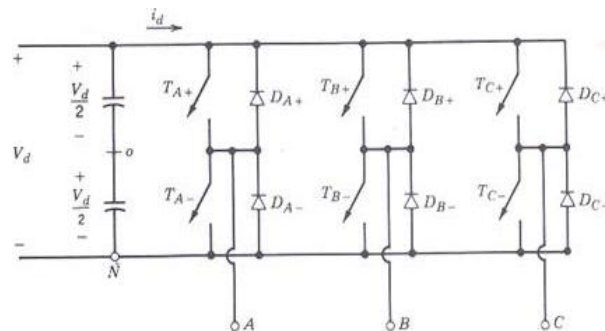

Fig 1. Three phase inverter.

Many applications that require an inverter use three-phase power. Two main examples are an ac-motor drive and uninterruptible power supplies. This lies of three legs, one for each phase. Each leg is basically setup in the same way as the one-leg inverter described above. In three phase inverters pulse-width modulations is used in the same way as it is before except that it much be used with each of the three phases. When generating power to three different phases one must make sure that each phase is equal, meaning that it is balanced. The Harmonics in the output are only of concern in the phase voltages. The harmonics output of each of the legs are exact to the harmonics in V_a. The odd harmonics exist as hidebound, gathers all over mf and it expands, mf is odd. Seeing the harmonic of mf, the phase difference will be equivalent to zero if mf is odd and a multiple of 3. Sequence, the harmonic at mf is overcome in the phase to phase voltage v_{ab}. The same is applied in the elimination of harmonics at the odd multiples of mf, if mf is chosen to be an odd multiple of 3. Therefore, some of the powerful harmonics in the one leg inverter can be erased from the phase to phase voltage of a three phase inverter. For low values of mf, to erase the even harmonics, a synchronized PWM should be applied and mf should be an odd integer.[8] Moreover, mf should be a multiple of 3 to cancel out the most dominant harmonics in the line-line voltage. Moreover, the slopes of $V_{control}$ and V_{tri} should be of the opposite polarity at the coincident zero crossings. During over modulation (ma > 1.0), regardless of the value of mf, the conditions pertinent to a small mf should be observed.

IV. LC FILTER

Output voltage wave is synchronized with the grid voltage.So the PWM inverter will inject ripple current in to the grid. The output LC filter is connected to remove highswitching frequency components from output current of inverter[2]. The simulation design of LC filter is shown in fig.4 where L= 10 e-3, C= 20 e-6. The filter is designed taking into account the following parameters for the grid and inverter as shown in Table I. The value of L is design based on current ripple. Smaller ripple results in lower switching and conduction losses. Typically the ripple current can be chosen as 10% - 15% of rated current. Considering 10% ripple at the rated current the designed value of inductor (L) in the system [3]-[4] .

 The capacitor C is designed based on reactive power supplied by the capacitor at fundamental frequency. In this design reactive power can be chosen as 15% of the rated power [3] .

V. MODULE OF THREE PHASE PWMINVERTER

The module of Three phase inverter is designed by using MATLAB simulation. Based on design and simulation results are shown. It is developed by line to line voltage VL-L of 415 V rms. The model is shown below in Fig.2.
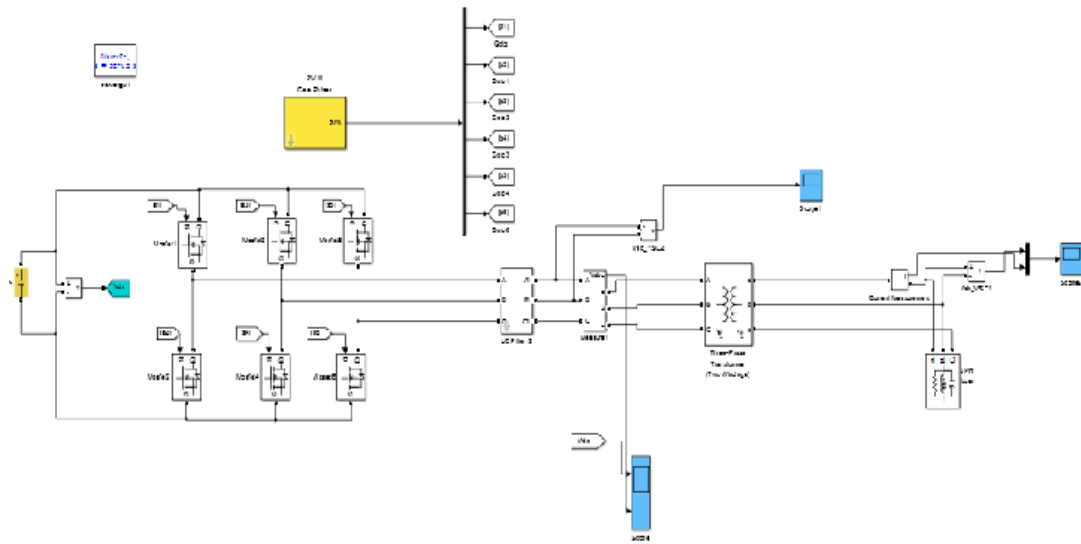
Fig 2. Three phase PWM inverter.

The module is designed by taking voltage source which remains constant connected to the three phase bridge converter. If we are taking the constant input voltage Vdc is 678 V then Vab L-L is 415 V rms is the phase to phase voltage. The equation is given below;

Vab(L-L) = 2*sqrt(2/3)* Vd (3)

The frequency is taken as 50 Hz. The three phase bridge converter consists of three leg MOSFET of internal diode resistance Rd= 0.01 Ω, FET resistance Ron=0.1Ω. It allows simulation of converters using both naturally commutated (or line-commutated) power electronic devices (diodes or thyristors) and forced-commutated devices (GTO, IGBT, MOSFET). The fig.3 shown below. PWM gate pulses is connected to the 3 phase bridge converter the control signal frequency (fc) is taken as 50, switching frequency as 20000 Hz and modulation index is 1. LC filter is connected to filter the unwanted harmonics. The output voltage and current is in per unit (pu) values or in volts and ampere. Based on the peak value of nominal phase to phase voltage parameter the block parameters are voltage parameter is measured from phase to phase not phase to ground and the signal label is Vabc_load. The three phase load parallel RLC load block the parameters taken nominal phase to phase voltage Vn (Vrms) is 415, nominal frequency (fn) is 50Hz, active power (P) is $5e_3$ W, load type is constant Z type.
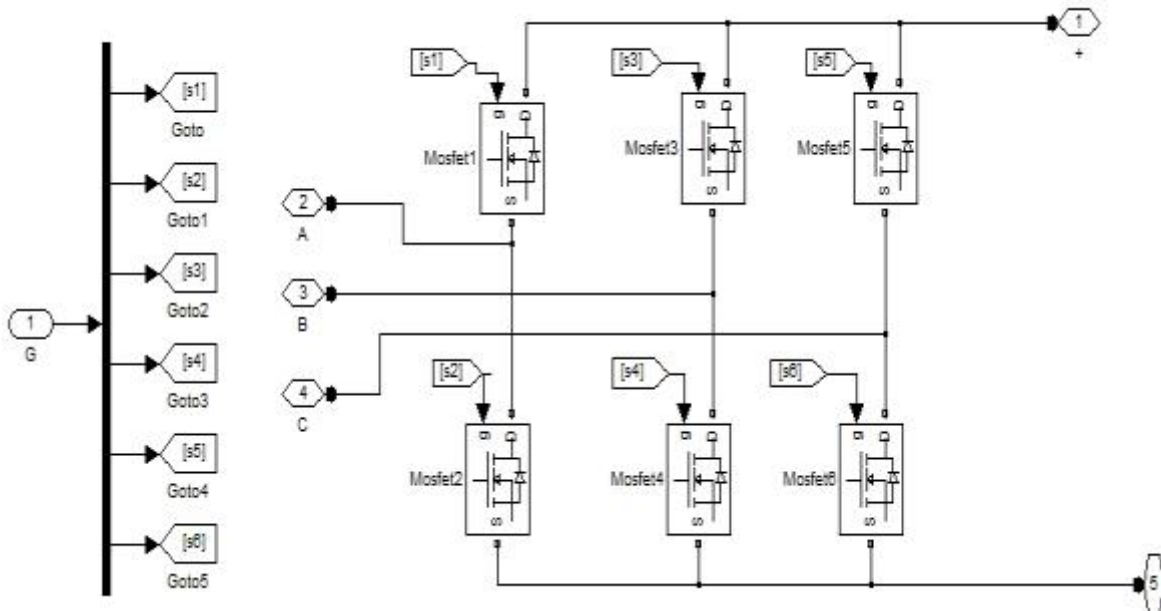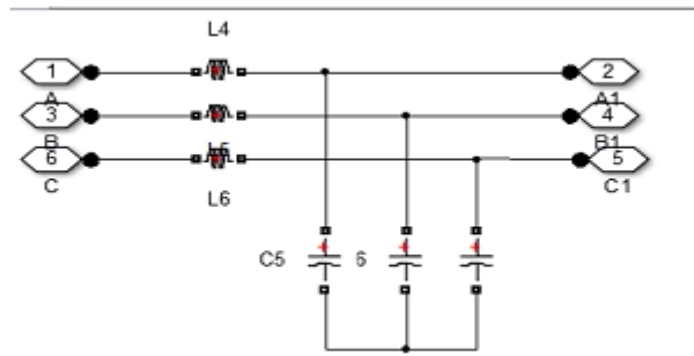

Fig 3. Three phase bridge converter.

Fig 4. LC filter.

VI. SIMULATION RESULTS

Based on the design, the simulation of entire system is done by MATLAB simulation results are shown below.
The output voltage of the three phase PWM inverter based on the voltage controller the output voltage of phase to phase or line to line of ab, bc, and ca of each phase with respect to time the waveform is shown in fig.5. The three phase voltage with the three phase load the output voltage waveform is sinusoidal is shown in fig .6 and the input voltage constant with respect to time is shown in fig.6.
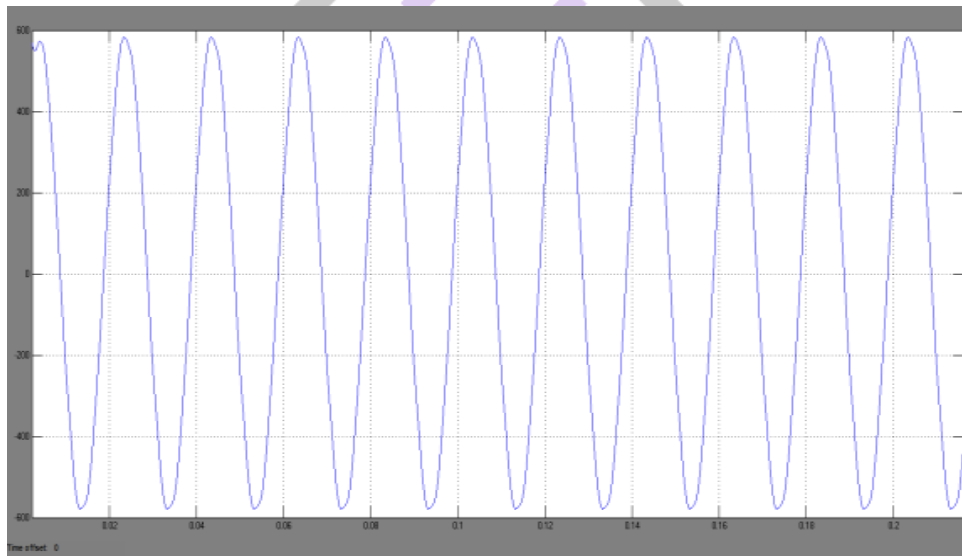
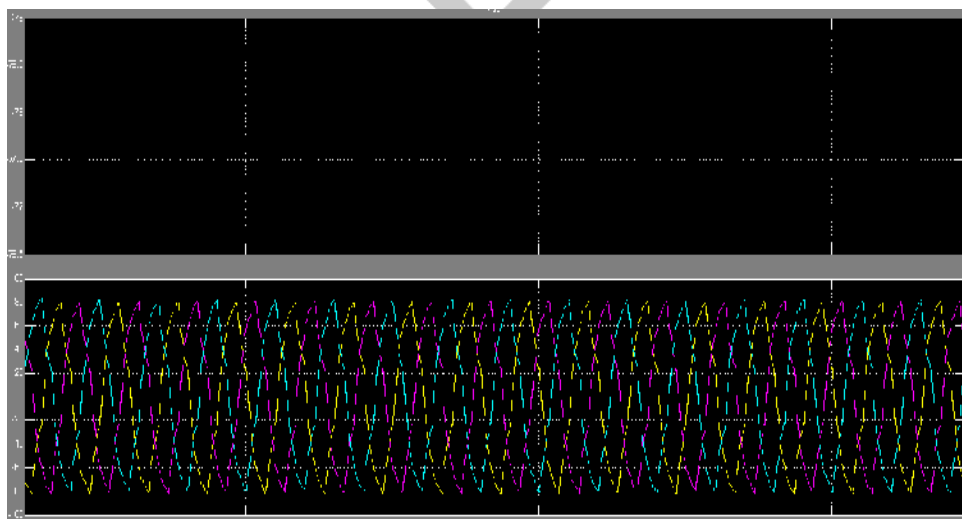

**Fig 5. Output voltage of each phase to phase
with time.**

Fig 6. Output voltage of three phase line load with time.

VII. CONCLUSION

This model mainly demonstrates a DC-AC converter. The three leg MOSFET operated inverter is constructed. It can be used to demonstrate the relationship of input DC, modulation index, filter selection and switching frequency third harmonic injection features. The simulation results has been carried out by MATLAB/ simulink.

The results are observed. It is carried out with voltage measurement not the current, it is a VSI. The phase to phase or line to line signal voltage is observed connectedto a three phase load.

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