MODELLING OF SINGLE PHASE TO THREE DRIVE SYSTEM WITH SPEED CONTRL USING PWM TECHNIC

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ABSTRACT

A general pulse width modulation (PWM) method for control of four-switch three-phase inverters is presented. The proposed vector PWM offers a simple method to select three or four vectors that effectively synthesize the desired output .The effect of Wye and delta motor winding connections over the pulse width modulator is also considered. Simulation and experimental results are presented to demonstrate the feasibility of the proposed approach.

The operating principle of the single-phase induction motor is complex than that of the three-phase induction motor. Those single phase motor gives low power output. For domestic applications where it require high starting torque normally large size single phase motor are available , but it is not working on full load therefore gives the less efficiency. The single phase motor require the separate arrangement for starting and three phase motor doesn't require such type of arrangement. In this project we use four (4) MOSFET instead of six (6),so we are reducing the switching losses in our project. The complete vector control scheme for the IM drive fed from the proposed 4S3P inverter is implemented in real-time using digital signal processor for a prototype 0.25 H.P. motor. A performance comparison of the proposed 4S3P inverter fed drive with a conventional 6S3P inverter fed drive is also made in terms of speed response and total harmonic distortion (THD) of the stator current. The proposed inverter fed IM drive is found acceptable considering its cost reduction and other advantageous features. A general pulse width modulation (PWM) method for control of four-switch three-phase inverters is presented. The proposed vector PWM offers a simple method to select three or four vectors that effectively synthesize the desired output voltage, even in presence of voltage oscillations across the two dc-link capacitors. The Proposed three phase drive have several advantages over the single phase drive such as reduction in power consumption, savage in copper material, reduction in size of motor, improved torque, improved speed-torque characteristics.

In a traditional single phase motor there is no self-start it gives stepped speed control and also less torque. It's not capable to with stand at overload for longer time. We are using SSLIMM(small low loss intelligent molded module) IC This intelligent power module provides a compact high performance AC motor drive in a simple rugged design.

KEY WORD:

4S3P:Four switch three phase,6S3P:Six switch three phase, RS: Stator resistances per phase, RR: Rotor resistances per phase, TNM: Torque in newton meters ,S :apparent power ,P :real power, PWM: pulse width modulator.

1.INTRODUCTION:

Three phase motor have higher range of efficiency than that of single phase motor and have a better starting torque. For single phase motor to achieve good starting torque they require more components like number of capacitor and centrifugal switch. Three phase motor has lesser price than the single phase motor same HP and synchronous speed rating. Three phase motor have no inherent torque pulsations. Single phase motors do have inherent torque pulsation .So three phase motor drive is very beneficial than single phase drive. Hence if we convert the single phase supply into the three phase supply and fed it to the three phases motor then it is more advantageous. A standard three-phase voltage source inverter utilizes three legs [six-switch three-phase voltage source inverter (SSTPI)], with a pair of complementary power switches per phase. A reduced switch count voltage source inverter [four switch three-phase voltage source inverter (FSTPI)] uses only two legs, with four switches. A general method to generate pulse width modulated (PWM) signals for control of four-switch, three phase voltage source inverters, even when there are voltage oscillations across the two dc-link capacitors. The method is based on the so called space vector modulation, and includes the scalar version. The proposed method provides a simple way to select either three, or four vectors to synthesize the desired output voltage during the switching period. The method utilizes the so called space vector modulation, and includes its scalar version. Simulation and experimental results are presented to demonstrate the feasibility of the proposed approach. Different vector combinations are compared. The effect of wye and delta motor winding connections over the pulse width modulator is also considered. The common mode voltage generated by the four-switch three-phase converter is evaluated and compared to that provided by the standard six-switch three-phase inverter.

2.BLOCK DIAGRAM:

Block Diagram Representation of Inverter Fed Induction Motor Drive is as shown in the Figure below. Ac source input is given to rectifier which convert dc to ac conversion Filter is used for eliminate ripple in ac pure ac is feed to inverter which convert constant ac to variable ac supply which is given to induction motor The detail of each block is explained below.

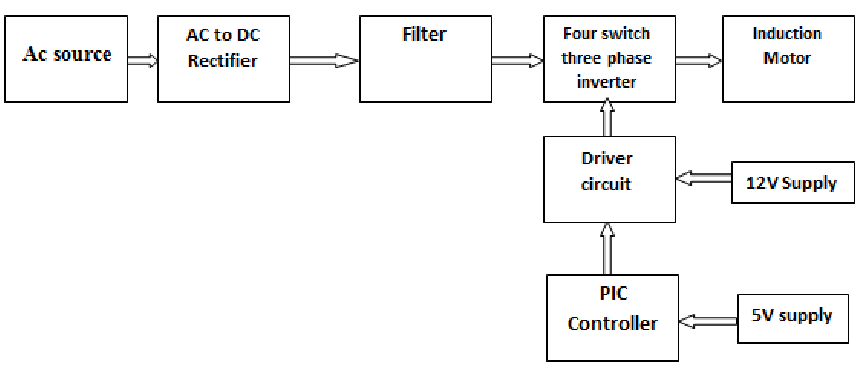

Fig.2.1. Block diagram of modeling of single phase to three phase drive techniques in single phase drive

Power supply

As we all know any invention of latest technology cannot be activated without the source of power. So it this fast moving world we deliberately need a proper power source which will be apt for a particular requirement. All the electronic components starting from diode to Intel IC's only work with a DC supply ranging from -+5v to 0-+12v. We are utilizing for the same, the cheapest and commonly available energy source of 230v-50Hz and stepping down, rectifying, filtering and regulating the voltage. This will be dealt briefly in the forth-coming sections.

Step down transformer

When AC is applied to the primary winding of the power transformer it can either be stepped down or up depending on the value of DC needed. In our circuit the transformer of 230v/0-12v is used to perform the step down operation where a 230V AC appears as 12V AC across the secondary winding.

Diode bridge rectifier

The ac input from the main supply is stepped down using a 230 /50V step down transformer. The stepped down AC voltage is converted into dc voltage using a diode bridge rectifier. The diode bridge rectifier consists of four diodes arranged in two legs. The diodes are connected to the stepped down AC voltage. For positive half cycle of the ac voltage, the diodes D1 and D4 are forward biased . For negative half cycles diodes D2 and D3 are forward biased. Thus dc voltage is produced to provide input supply to the DC-DC Converter. When the positive half cycle is applied to the diode bridge rectifier, the diodes D1 and D4 are forward biased. The diodes start conducting and the load current flows through the positive of the supply, diodeD1, the load, the diode D4 and the negative of the supply. The diode D2 and D3 are reverse biased and do not conduct.

Filter Unit

Filter circuits which are usually capacitors acting as a surge arrester always follow the rectifier unit. This capacitor is also called as a decoupling capacitor or a bypassing capacitor, is used not only to 'short' the ripple with frequency of 120Hz to ground but also to leave the frequency of the DC to appear at the output.

Four switch three phase inverter

In case of this only four MOSFET is use they at as a switch and two capacitor are use they act as filter in it the project. The rating is 1000µf and voltage rating is 50V. it convert DC in to three phase ac which is used to control drive speed.

Modeling of the drive system and control approach -

As per the diagram, the complete drive system modeling involves the modelling of the IM, inverter and the controller, which are discussed in the following subsections

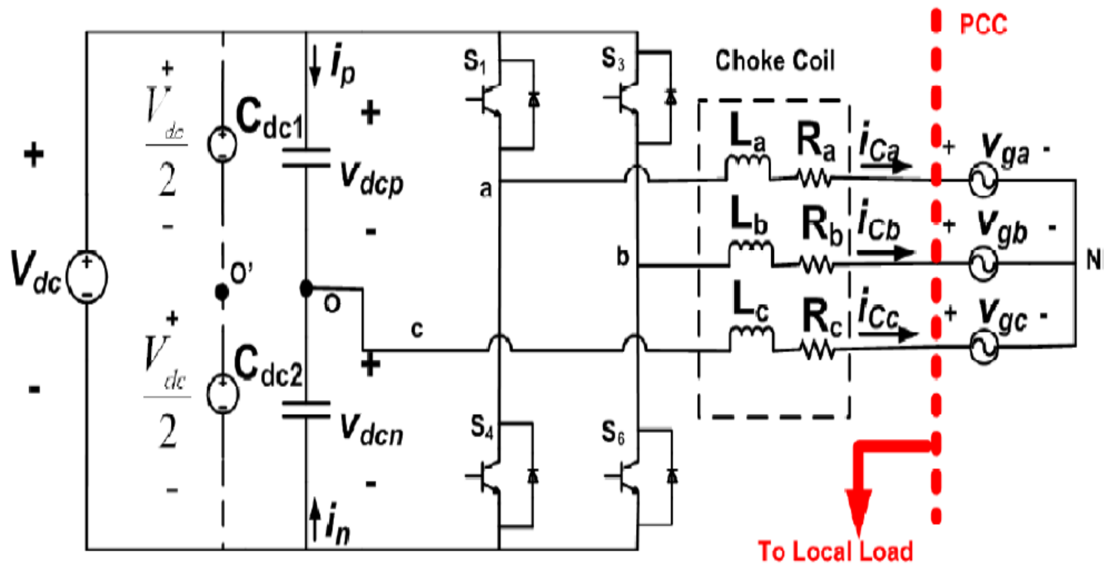

Figure.4.1. Circuit diagram of 4S3P invertor

Vdc given by the rectifier gives to input of invertor which convert DC to 3ph AC as shown in Fig 4.1.induction motor represented in its equivalent RL circuit parameters.

Rectifier model:

It implies diode bridge rectifier which converts the AC supply into DC and LM7805 is used as a voltage regulator IC.

Four switch three phase inverter model :

To establish the feasibility of system, the experimental implementation is carried out using Xilinx software with SPARTAN-3 processor. This is equipped with appropriate plug-in boards for power switch control. The multi meter and digital storage oscilloscope is used to measure the output current and voltage of FSTPI. A complete hardware setup is described in the Table . Hardware component details Components Ratings Capacitor 1000µf, 250V Inverter MOSFET (IRF 460)- 4Nos Induction Motor 0.5 hp ,3-phase, 50Hz,400V Processor SPARTAN-3, model XC3S200 Rectifier 110+Nos,5A Diode Bridge Rectifier Driver Circuit Board The complete set up (FPGA processor board, Driver Circuit, FSTPI, and 3-phase IM) is shown in fig.

Motor Rating	**0.5 hp,380V,4-Pole,50 Hz**
Stator inductance	18.8 mHz
Stator Resistance	11.1Ω
Rotor Inductance	26.7mH
Rotor Resistance	12.3Ω
Magnetising Inductance	467Mh
Inertia Kg m^2	0.01
Friction Coefficient Kdf	0.02

Table : Parameter of 0.5 HP, 3ph motor.

The output pulses waveforms of switch S1, S2, S3, and S4 are obtained from the driver circuit are taken by the Digital Storage Oscilloscope.

Components	Ratings
Capacitor	0.001f,250V
Inverter	MOSFET (IRF 460)-4Nos
Induction Motor	0.5 hp,3 phase,50 Hz,400V
Processor	SPARTAN-3,model XC3S20
Rectifier	110+Nos,5A Diode Bridge Rectifier
Driver Circuit Board	-

Table . Component and its ratings use in model

Sinusoidal pulse width modulation

In the Sinusoidal pulse width modulation scheme, as the switch is turned on and off several times during each half-cycle, the width of the pulses is varied to change the output voltage. Lower order harmonics can be eliminated or reduced by selecting the type of modulation for the pulse widths and the number of pulses per half-cycle. Higher order harmonics may increase, but these are of concern because they can be eliminated easily by filters. The SPWM aims at generating a sinusoidal inverter output voltage without low-order harmonics. This is possible if the sampling frequency is high compared to the fundamental output frequency of the inverter. Sinusoidal pulse width modulation is one of the primitive techniques, which are used to suppress harmonics presented in the quasi-square wave.

Pulse width modulation technique:

The advent of the transformer less multilevel inverter topology has brought forth various pulse width modulation (PWM) schemes as a means to control the switching of the active devices in each of the multiple voltage levels in the inverter. The most efficient method of controlling the output voltage is to incorporate pulse width modulation control (PWM control) within the inverters. In this method, a fixed dc. input voltage is supplied to the inverter and a controlled a.c. output voltage is obtained by adjusting the on and–off periods of the inverter devices. Voltage-type PWM inverters have been applied widely to such fields as power supplies and motor drivers. This is because: (1) Such inverters are well adapted to high-speed self turn-off switching devices that, as solid-state power converters, are provided with recently developed advanced circuits; and (2) they are operated stably and can be controlled well.

The PWM control has the following advantages:

(i) The output voltage control can be obtained without any additional components.

(ii) With this type of control, lower order harmonics can be eliminated or minimized along with its output voltage control. The filtering requirements are minimized as higher order harmonics can be filtered easily.

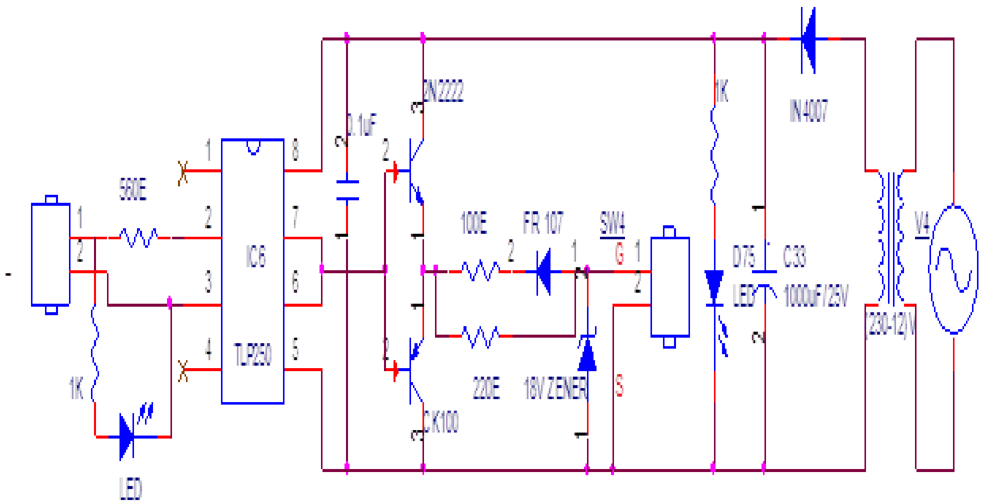

Figure : Gate triggering pulse circuit for MOSFET

The commonly used PWM control techniques are:

(a) Sinusoidal pulse width modulation (sin PWM)
(b) Space vector PWM

The performance of each of these control methods is usually judged based on the following parameters:

- Total harmonic distortion (THD) of the voltage and current at the output of the inverter.
- Switching losses within the inverter.
- Peak-to-peak ripple in the load current.
- Maximum inverter output voltage for a given DC rail voltage.

From the above all mentioned PWM control methods, the Sinusoidal pulse width modulation (sin PWM) is applied in the proposed inverter since it has various advantages over other techniques. Sinusoidal PWM inverters provide an easy way to control amplitude, frequency and harmonics contents of the output voltage.

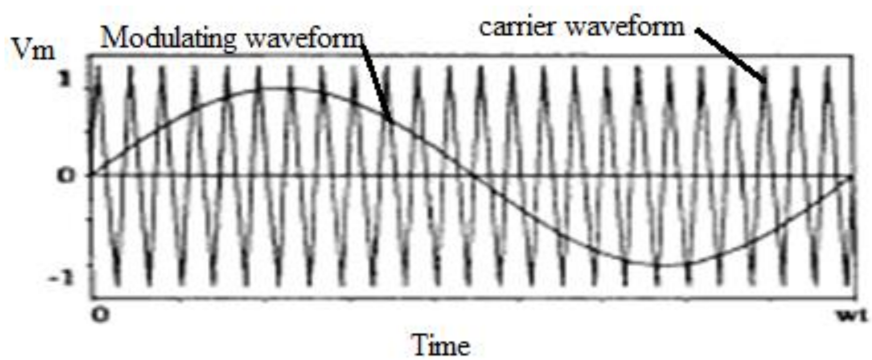

Fig:.Modulating/reference and carrier waveform

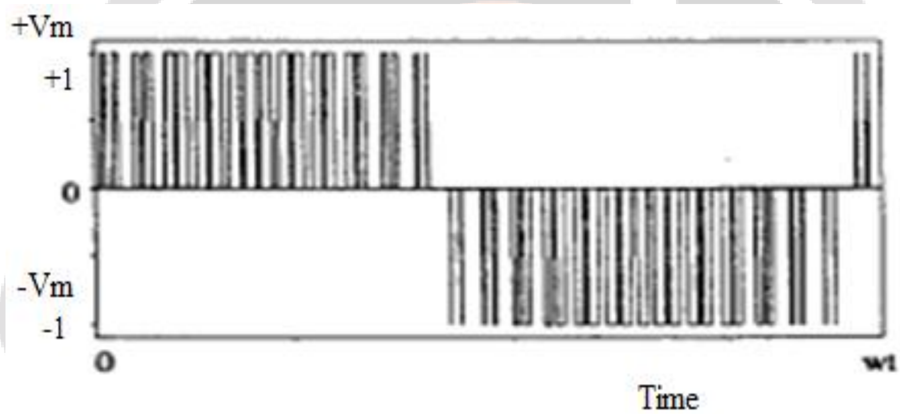

Fig:Line-to-line output waveform.

Driver circuit:

It is used to provide 9 to 20 volts to switch the MOSFET switches of the inverter driver amplifies the voltage from microcontroller which is 5volts. Also it has an Optocoupler for isolating purpose so damage to MOSFET is prevented.

Driver circuit operation:

The driver circuit forms the most important part of the hardware unit because it acts as the backbone of the inverter because it gives the triggering pulse to the switches in the proper sequence. IC TLP250 is Optocoupler provide isolation between power circuit and control circuit resistor give current limitation purpose if any transient occur in power circuit it protect control circuit The diagram given above gives the circuit operation of the driver unit. The driver unit contains the following important units.

- Optocoupler
- Totem pole
- Capacitor
- Supply
- Diode
- Resistor
- Buffer IC –CD4050
- Darlington pair circuit
- MOSFET

Controller model

The outputs of the controllers are in the form of four logics. Those logics are used to switch on and off the inverter power switches. The controller models as per the table 3.1 decide which switch is going to operate at the time of operation.

3.RESULT TABLE

Parameter	Practical value	Simulation value	Actual value
Voltage L-L	37	38	50
Current	0.55	0.5	1
Power	42.86 W	39.87W	50
Power saving	7.14W	10.13W	——

4.ACKNOWLEDGMENT

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5.CONCLUSION

A cost effective 4S3P inverter fed IM drive has been developed, simulated and successfully implemented for a prototype 1 hp motor. The proposed control approach reduces the cost of the inverter, the switching losses, and the complexity of the control algorithms and interface circuits as compared to the conventional 6S3P system to achieve high performance.

The performance of the proposed drive is investigated both theoretically and experimentally at different operating conditions. A performance comparison proposed 4S3P inverter fed drive with a conventional 6S3P inverter fed drive is also made in terms of total harmonic distortion (THD) of the stator current inverter based drive. Three phase motor is less costly and less toque pulsation and it is self-starting motor.

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