Three-phase single switch PWM controlled Induction motor drive

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***Abstract*- This paper presents a realization to obtain high efficiency and control on power factor of three phase high power Induction motor Drive and Three phase squirrel cage Induction motor require less maintenance and rugged in construction. The proposed Three phase induction motor drives makes used of single controllable switch connected across the three phase diode bridge rectifier forming A.C. switch for chopping three phase A.C. voltage With the help of proposed topology .the chopped three phase A.C. voltages appear across stator voltage terminals of three phase induction motor .The magnitude of A.C. voltage is controllable with the help of high frequency PWM .the specialty of these scheme with high frequency controlling the speed of induction motor with high frequency of single semiconductor switch and no freewheeling switch .The speed of the three phase induction motor with fan load will be controllable within around 50% of the rated motor speed. This drive would find utility in Industrial high power cooling fans, blowers and pumps. Proposed drive is expected to provide higher efficiency, high power factor and required speed range for above applications with simplicity and economy**

***Index terms*- PWM control; Triangular pulse genrator; Three- phase Induction motor**

I.INTRODUCTION

In Today's era power conservation is an issue across the globe. This project mainly deals with the minimum power consumption by enhancing the efficiency and offering capacitor as a freewheeling of Three phase squirrel cage Induction motor, it requires less maintenance and rugged in construction .For industrial application induction motors are most preferred in pumps, Fans and blower. Speed control of these machines can be achieved by different methods [1].

The disadvantage of firing angle control technique is very low power factor at lower speed range and there by increased in source current requirement for a particular required power output, the second technique of speed control which is common and wide popular is variable frequency drive with this technique the speed is controllable in wide range but it requires one additional power factor improvement stage using additional bridge rectifier and power semiconductor switch in boost converter topology the efficiency of the converter gets reduced due to this additional stage and complexity and cost of the circuit is also gets increase .the inverter is fabricated with the help of six controllable switches operated in sequential manner .the control techniques required accurate sequential control of six switches using SPWM or SVPWM.

II. PROPOSED TECHNIQUE

Phase angle control (PAC) technique was earlier in use for this purpose but it suffers from inherent disadvantages such as lagging power factor at the input side especially at lower speeds due to increase in firing angle.

To overcome above disadvantages, the proposed research work focuses on reducing power consumption and improving power factor of three phase induction motor drives. A variable voltage control scheme is proposed for induction motor drives. A high Frequency PWM controlled direct AC to AC voltage controlled converter is proposed for three phase induction motor to improve the drive efficiency and input power factor along with fan speed control. In the proposed work only one main active switch and six back-to-back connected diodes are presents. However ,the continuity of the current in the stator winding of the motor is maintain with the help of parallel connected low value capacitors causing freewheeling action in both the positive and negative half of AC voltages. The r.m.s. voltage fed

to the motor is controllable simply by duty ratio control the motor current is not allowed to lag much as in case of firing angle control scheme. The smooth starting and speed control of induction motor is possible with high efficiency and high power factor. The advantages of proposed scheme are high frequency PWM switching by eliminating additional three A.C. switches instead of that we are using here three parallel connected extremely low value capacitor, with high power factor, high efficiency and minimum number of controlled power semiconductor switches are required. The specialty of the proposed scheme is that here we are using single active switch instead if using six or four A.C. switch topology. In this scheme the drive can operate in entire range of controllable speed and torque unlike conventional phase angle control scheme. Besides this, the additional advantage of this method is that supply current from AC source becomes leading. The triggering technique used for power electronic devices is opposite to that of firing angle control. The devices are turned on at zero crossing and turned off at desired instant in every half cycle. The motor voltage is controllable in the entire range from zero to full voltage. The supply current in this case becomes leading.

A. POWER CIRCUIT:

The proposed scheme is used to modify Induction motor drive with single controllable switch and six power diodes operated in high frequency PWM manner. The three phase AC supply is fed to the induction motor which will be controllable by single power MOSFET by duty ratio control, the power circuit consist of only single controllable switch and six power diodes .The three phase induction motor is connected between AC source and AC input terminals of three phase bridge rectifier .The controllable switch that is power MOSFET or IGBT switch is placed across the output terminals of the three phase bridge rectifier .The controllable switch therefore always remain in Forward bias condition On application of the gate pulse to the power semiconductor switch the motor terminals at the input bridge rectifier get short circuited and the motor therefore draws current from the AC source whose path is completed through bridge rectifier and power semiconductor switch. In this mode of operation the motor is connected in star fashion. When the power semiconductor switch is turn off by removing gate pulse the current through the motor would reduce but circulated in same direction through parallel connected high voltage low value capacitors during short time interval .The phenomenon of turning off and on of the semiconductor switch is continue with the help of high frequency PWM pulses generated by control circuit. A small low cost 555IC is used both for pulse generation and for gate driver .The current is drawn from the source by the motor during short time interval whereas the current is not drawn by the motor during turn OFF period of the power semiconductor switch . However ,the continuity of the current in the stator winding of the motor is maintain with the help of parallel connected low value capacitors causing freewheeling action in both the positive and negative half of AC voltages. The r.m.s. voltage fed to the motor is controllable simply by duty ratio control the motor current is not allowed to lag much as in case of firing angle control scheme .the motor current almost remains near zero crossing of source phase currents always remains in phase with applied phase voltage because of the high frequency PWM operation. The challenge in the problem is to provide variable three phase AC voltage to the induction motor and at the same time maintaining DC voltage across power semiconductor switch. This is achieved with the help of proposed topology which is novel.

B. MODE OF OPERATION:

Mode 1: Conduction mode

Switch S1 is made ON at the instant t0, current flows through stator windings a-a', b'-b and c-c' during interval t0- t1 and the induced voltage polarity across stator winding, with the positive rising current at the current entering end and negative at the leaving end is as shown in fig.1.The voltage applied to the stator winding is equal to the instantaneous value of the respective source voltages.

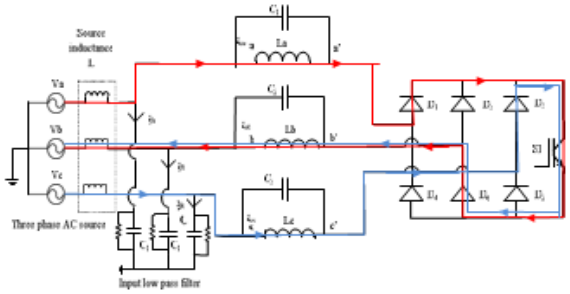


Figure1. Conduction mode (0 -60)

Mode 2: freewheeling mode

During interval t1-t2 (freewheeling mode) the current starts decreasing in the stator winding and polarity of the voltage induce across stator winding reverses .the current freewheels in the same direction as that of mode-1 through parallel connected capacitor across each stator winding as shown in fig.2.In this mode no current is drawn from the source . The voltage applied across the coil of stator winding is zero during this mode. The mode-1 and mode-2 operation repeats n-times during each 60 degree interval of 50Hz voltage cycle .The direction of one of the phase currents will be changing cyclically interval, 50times during interval 0-60 for switching frequency equal to 3KHz.

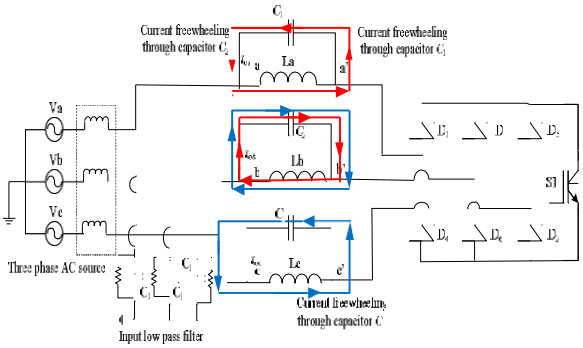


Figure 2. Freewheeling mode (0 -60)

III. SIMULATION RESULTS

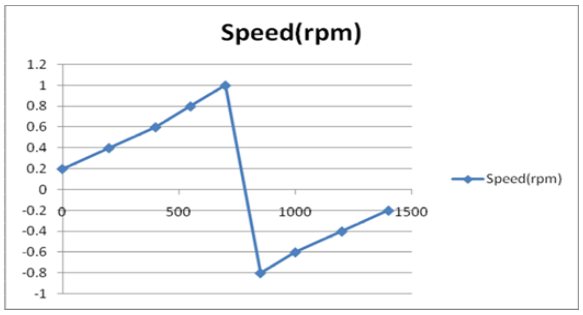
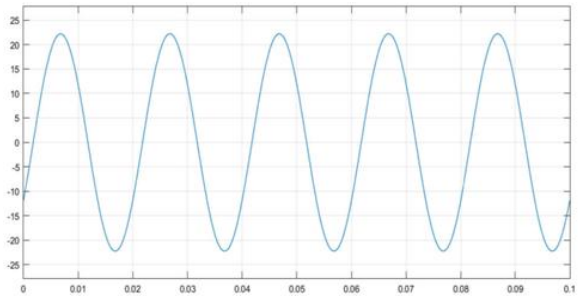
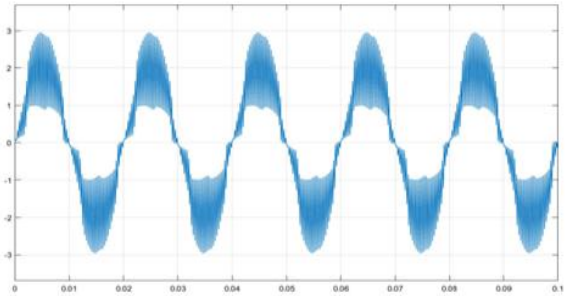


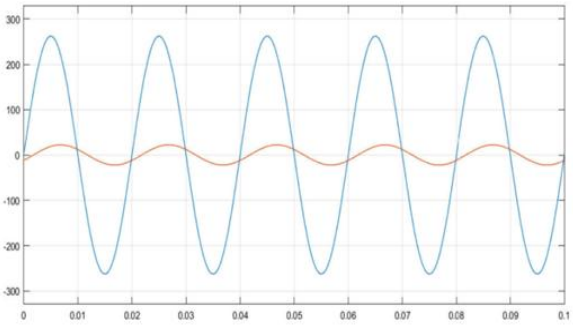
Figure 3. Simulation Results



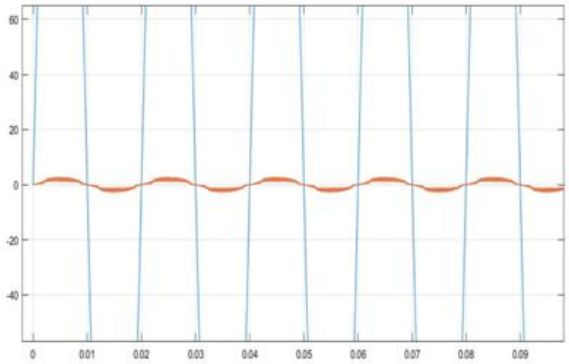
MAGNITUDE OF PHASE CURRENT WITHOUT IGBT



MAGNITUDE OF PHASE CURRENT WITH IGBT



Iph LAGS Vph BY PF ANGLE



Vph AND Iph IN PHASE

IV. CONCLUSION

In this paper instead of using four or six A.C. switches we are using here extremely low value capacitor parallel connecting with stator winding of induction motor drive .The variable PWM controlled pulses will be generated by comparing high triangular career wave with variable reference D.C. controlled voltage ranging from 0-10v and motor speed will be varying by the duty ratio of IGBT switch, the A.C. voltage across three-phase induction motor and thereby r.m.s. A.C. current can be controlled . The frequency of IGBT switch will performing noiseless of induction motor drive. A proposed scheme to implement energy savings of three-phase induction

motor drive. Economic energy efficient high power factor, reduced number of semiconductor switches, Reduced initial cost, Simplicity of control, More reliable due to less components and less power semiconductor switches, Lower size, weight and volume of the drive ,Soft start, High power factor and high efficiency.

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