Improved Power Factor of High frequency Switched Single Phase Induction Motor Control

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Abstract *- To obtain high efficiency and control on power factor of single phase Induction motor Drive, the proposed High Frequency PWM control technique is presented. Only one semiconductor controlled switch is used. This drive would find utility in Residential and domestic purpose Ceiling fans, blowers and air coolers. The fan draws more current than the required one. This leads to higher I^2R Cu losses occurring in the stator of the single phase motor. This motor is expected to draw lesser current at higher input power factor as compared to existing firing angle controlled speed controlled techniques. Proposed drive is expected to provide higher efficiency, high input power factor, low Cu loss and reduced low order harmonics for above applications with simplicity and economy*.

Keywords - High Frequency, PWM, Power Factor

1. INTRODUCTION

Low power Single phase Induction motors are widely used for domestic utility fan motor applications, e.g. Ceiling fans, table fans, air coolers, blowers which are required to run continuously for a long time and also need speed control provision. This project mainly deals with the minimum power consumption by enhancing the efficiency and offering AC Single phase induction motor drive, which are mostly used in residential and domestic purpose. Single phase induction motor is more widely used in the domestic utility than other machines due to their advantages such as simplicity in construction, reliability in operation, and cheapness. The speed control of such motors can be achieved by just controlling the voltage on the motor by the use of power electronic devices. The various control techniques are used for improvement of power factor in the DC converters, and similar to use for ac controller. This technique achieved speed control for regulating the variable AC voltage using an extinction angle control technique [1]. The voltage drop obtains in system impedance then the current flows from the individual harmonic, since the output of the voltage waveform distortion [2]. But this suffers from several disadvantages such as retardation of power factor due to increase in Extinction angle at lower speeds, complex control techniques and number of switches. In [3], the residential applications of future energy challenge which has been studied a less expensive integrated drive system. In [4], different capacitors used in different situations, but drawback of this technique is less efficient than other methods. In [6], Adjustable Speed of single phase induction motor drives has been studying various topologies i.e. converter topologies, the adjustable frequency PWM inverter. High Frequency PWM control Technique is used to minimize the above drawbacks of firing angle controlled drives. With High Frequency PWM control drive, power factor (PF) and efficiency of induction motor improves as compared to previously used firing angle controlled drive. In order to further improve the efficiency and power factor the proposed drive scheme is presented. The proposed drive can operate an induction motor with high PF ranging from lagging to leading or even at near unity for speed range required for fans and blowers. This could have been achieved with the help of High Frequency PWM control. The control circuit for the drive is simple and economic. The power circuit of the drive consists of only one semiconductor controllable switch. Experimental results of power factor, displacement factor and total harmonic distortion factor are described and discussed. In order to further improve the efficiency and power factor the proposed drive scheme is presented. The proposed drive can operate an induction motor with high power factor (PF) ranging from lagging to leading or even at near unity for speed range required for fans and blowers. This could have been achieved with the help High Frequency PWM control of single phase motors are driven using the proposed drive, plenty of power conservation is possible.

2. POWER CIRCUIT OF THE PROPOSED DRIVE

The power circuit of the proposed technique is shown in Fig.1. In this diagram single phase AC supply is connected to Diode bridge rectifier. In this technique, the motor requires variable AC and motor load connected in between single phase AC supply and the input side of the bridge rectifier. The MOSFET is connected across the output terminal of the bridge rectifier which is forward biased. A freewheeling capacitor is connected across the motor terminal to freewheel the AC current through the motor, which is turned off time of the MOSFET switch. The proposed techniques make use of a single controllable switch .The speed control technique used is high frequency PWM control. In this technique, the overall circuit requires only one switch along with four power diode in bridge configuration.

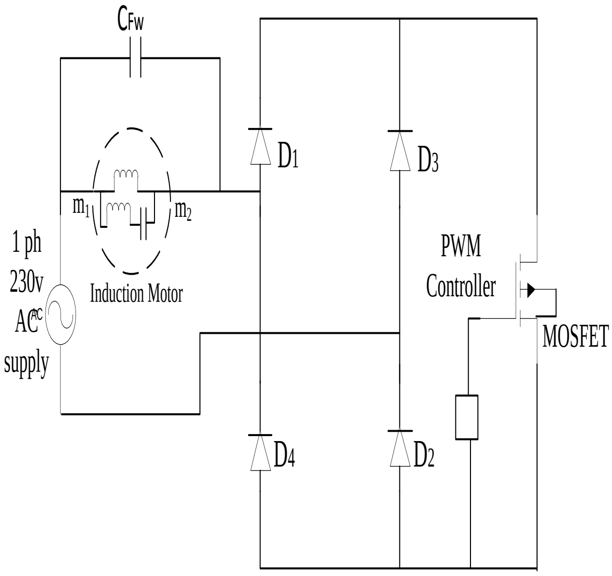

Figure.1 Power Circuit of Proposed Drive

In this method a capacitor is performing the freewheeling action in place of conventionally used additional freewheeling switch. The RMS output voltage of the motor and thereby the speed of the induction motor would be controllable by fixed High frequency PWM control. The source current waveform, therefore, remains in the same phase with the source voltage giving rise to high input power factor. The controllable switch therefore always remains in a 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.

3. CONTROL TECHNIQUE

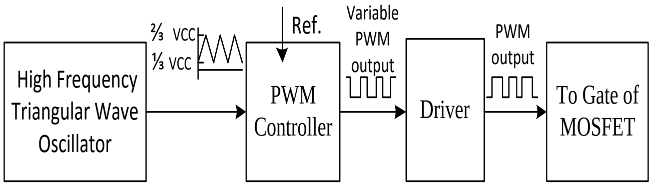

Figure.2. Block Diagram of Controller Circuit

In Controller Circuit, the High Frequency oscillator generates the triangular wave whose magnitude vary in between Vcc which is shown in figure.2 then outputs given to the non inverting input of duty ratio controller. In the duty ratio controller, i.e. PWM controller, which is generate the inverting High Frequency PWM wave and then this inverting wave gives driver fed to gate pulses.

4. PROPOSED HARDWARE WORK

Fig. 4. Hardware Model

The hardware implementation of high frequency PWM control in fig. 4. In this model, single phase 230V AC supply connected to the 9V transformer which is step down the voltage level. Then, this is connected to the input side of the Bridge rectifier in the controller circuit. A gate pulse of the controller circuit is connected to the input of single phase bridge rectifier of the power circuit. Then output of the single phase bridge rectifier is connected to the fan motor.

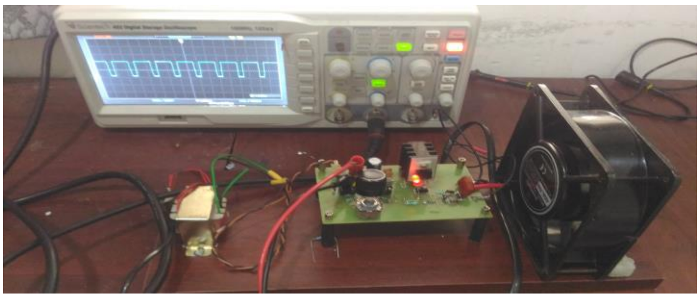

Fig. 5. Hardware Model with Setup

In above model shows the with testing of the digital storage oscillator which shows the output of the controller circuit i.e. triangular waves through high frequency triangular wave oscillator and inverting PWM waveforms through the comparator then PWM waveforms through the driver circuit of the controller which is gives to the Gate of the MOSFET Switch.

5. EXPERIMENTAL RESULTS

Fig. 5 shows the measured variation of the total harmonic distortion factor (THDF) of the input current versus the rms output voltage for different load conditions. In this Figure as the extinction angle increases then output voltage decreases therefore, the THDF in the supply current increases. Also, the THDF increases so, load power factor decreases. That means it is for the same load condition, which is increase in the THDF with the input power factor goes from lag to lead as well as displacement factor. Although the increase in THDF will reduce the value of the supply power factor, however, it will not affect its leading nature.

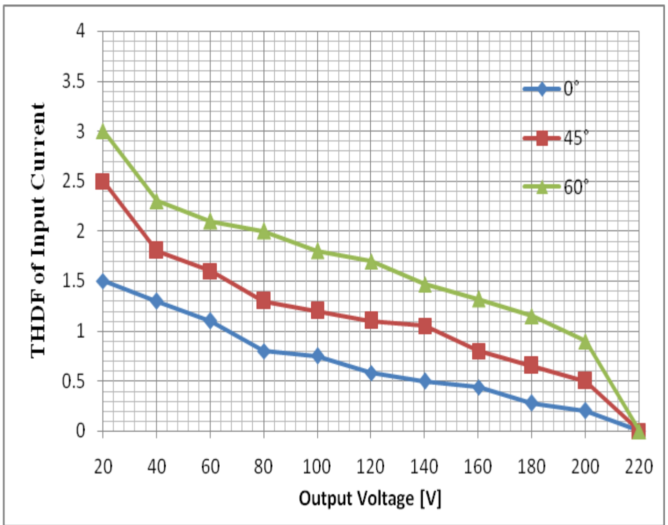

Fig. 5.Variation of THDF of Input current with the output voltage

The simulation results in fig. 6 are the improvement in the input power factor with the Speed in RPM which gives a nearly unit power factor at 700 RPM speed of the single phase induction motor and lagging input power factor at full speed of the motor.

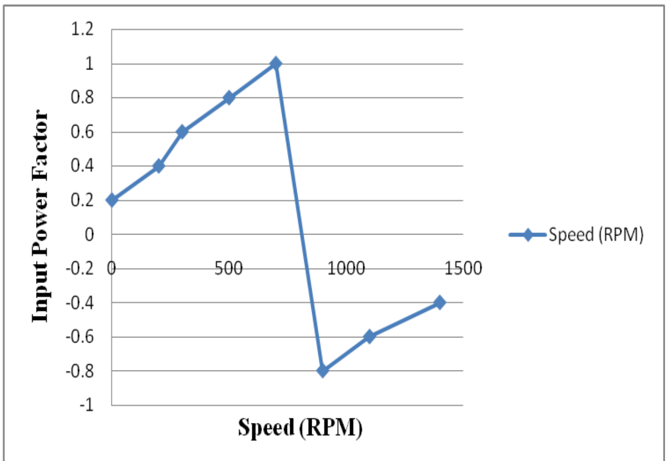

Fig.6. Variation of Input Power Factor with the Speed in RPM

Fig.7. demonstrate the computation of the measured rms value of the motor applied voltage with the extinction angle. A signification of improvement in the input power factor with the extinction angle control is shown in Fig. 8 which is gives the variation of the THDF of the input current with the motor applied voltage.

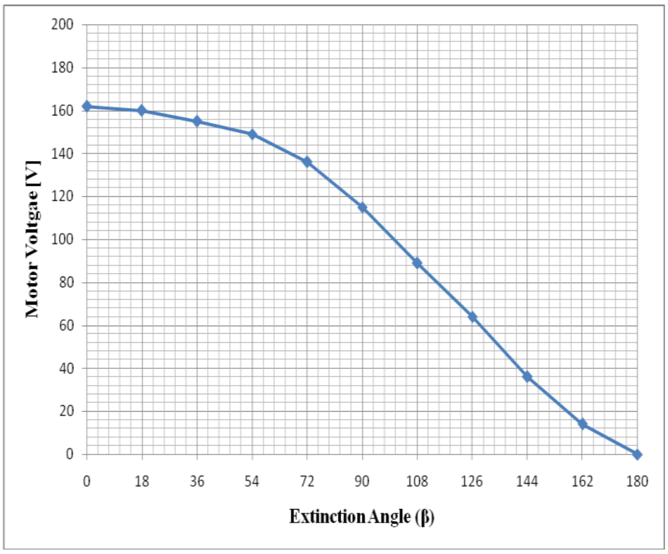

Fig. 7. Variation of Motor applied voltage with Extinction angle (β)

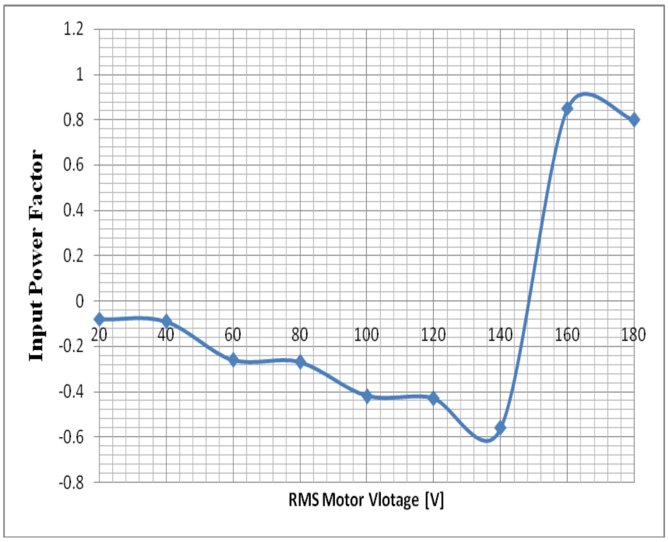

Fig. 8. Variation of the Input power factor with the motor voltage

6. CONCLUSION

In this paper, the prototype model of High frequency PWM control technique is implemented and this technique provides improvement in input power factor. The voltage controller of high frequency PWM control technique has been applied which is single phase induction motor loaded by a fan. The single phase induction motor speed control is also achieved and efficiency is high. Hence, Stator current is lower as compared to the existing techniques. Thus, this technique is suitable for speed control of single-phase induction motor as it is required a simple and less costly technique.

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