Single Phase Induction Motor Control with Improved Power Factor using single switch

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Abstract **- Phase angle controlled converter using back to back Thyristors or Triacs are being adopted to controlled the speed of voltage controlled single phase Induction Motor used for Fan / Blower loads. This method suffers from the disadvantages of low input power factor at lowers speeds due to low power factor. The fan draws more current than the required one. This leads to higher I²R Cu losses occurring in the stator of the single phase motor. The proposed techniques of High Frequency PWM Controlled are proposed. This motor is expected to draw lesser current at higher input power factor as compared to existing firing angle controlled speed controlled techniques. In this way, the motor would operate at higher efficiency, low Cu loss, high input power factor and reduced low order harmonics.**

Keywords**— High Frequency, PWM, Power Factor**

I. 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.

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. The performance of this technique which has to be verified the results of the displacement factor as per given to static load. Therefore the static and dynamic load is applied for inductive load of the AC voltage controller then the `output shows variations in rms voltage and extinction angel value[1]. But the drawback of this technique is lower power factor and efficiency as compared to the proposed techniques.

Reduces total harmonic distortion and improve the power factor has to be developed by a single phase induction motor for AC power[2]. To overcome the harmonic distortion, which is used in designing methods and improve the power factor also which is used power factor correction method. The voltage drop obtains in system impedance then the current flows from the individual harmonic, since the output of voltage waveform distortion. Therefore, this technique also suffer from disadvantages of losses are increased and voltage level also decreases as proposed methods. The residential applications of future energy challenge which have a less expensive integrated drive system [3]. The single phase induction machine system which has to remain cost competitive while performing system. This application required power factor more than 0.8 which is operated as power factor correction boost rectifier. Since, their efficiency range is desired to their specific load range and the power factor will be increased. The disadvantages of this topology of lower power factor at lower speed range as compared to proposed techniques.

In-order to minimize the above mentioned dis-advantages of low power factor and higher copper loss in the motor, a high frequency pulse width modulation control is proposed.

II. PROPOSED TECHNIQUES

The proposed techniques makes use of single controllable switch .The speed control technique used is high frequency PWM control. In this technique, overall circuit requires only one switch along with four power diode in bridge configuration.

2.1 POWER CIRCUIT

In this technique a single controllable switch using a Power MOSFET is deployed along with a single phase rectifier, forming an AC controllable switch. In this topology the motor which requires variable AC is connected at the input side of the bridge rectifier. In this method the fan motor is connected in between AC source and input of single phase bridge rectifier and the MOSFET which requires to be forward biased all the time is connected across the output terminals of the single phase rectifier. A low value high voltage capacitor is connected across the motor terminals to freewheel the AC current through the motor during the turn-off period of MOSFET switch.

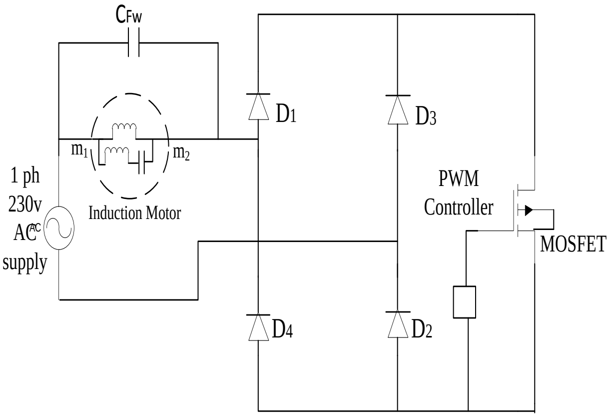


Figure.1 Power Circuit of Proposed Drive

In this method a capacitor is performing 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 wave form therefore remains in same phase with the source voltage giving rise to high input power factor. The source current is expected to reduce as compared to firing angle control technique for same motor speed [1].

III. MODES OF OPERATION

The operating modes of proposed drive are divided into four modes:

I] Conduction modes for Positive Half Cycle
II] Freewheeling mode for Positive Half Cycle
III] Conduction modes for Negative Half Cycle
IV] Freewheeling mode for Negative Half Cycle

I] Mode 1, Conduction mode for Positive Half Cycle :

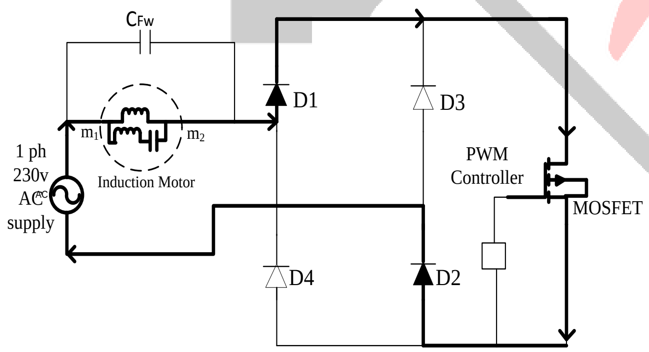


Fig. 2-a. Mode 1 : Conduction Mode – Positive half cycle

In conduction mode, current flows from source to the motor ($m_1 - m_2$) - diode D_1 – MOSFET - diode D_2 - back to the source shown in fig. 2(a).

II] Mode 2, Free Wheeling mode for Positive Half Cycle :

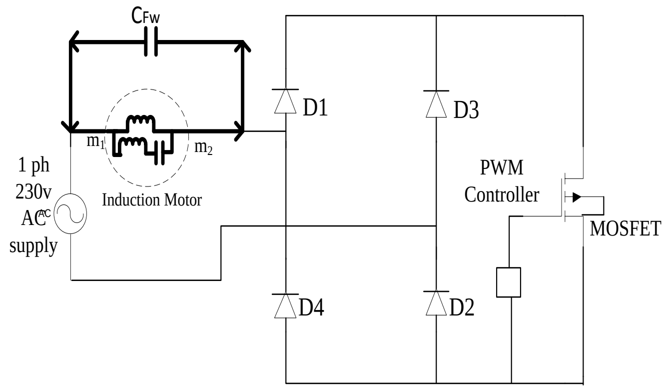


Fig. 2-b. Mode 2 : Free Wheeling Mode – Positive half cycle

In this mode, Current circulates in the motor and parallel connected capacitor C_{fw} in the same direction as it was in mode 1 shown in fig. 2(b). This mode is called as Free Wheeling Mode for Positive half cycle.

Mode 1 and mode 2 are repeated number of times in positive half cycle. The number of switching intervals depends on applied switching frequency.

III] Mode 3, Conduction mode for Negative Half Cycle :

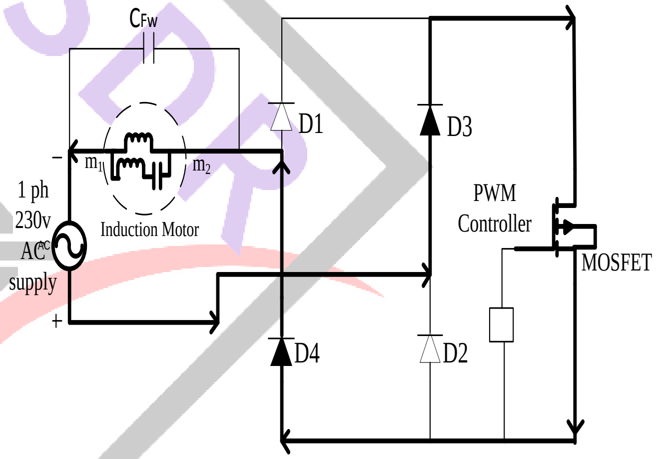


Fig. 2-c. Mode 3 : Conduction Mode – Negative half cycle

In conduction mode, current flows from source to the motor ($m_2 - m_1$) - diode D_3 – MOSFET - diode D_4 - back to the source shows in fig. 2(c).

IV] Mode 4, Free Wheeling mode for Negative Half Cycle :

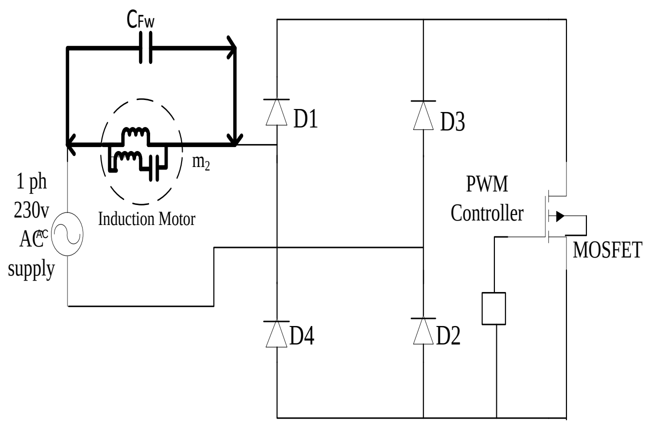


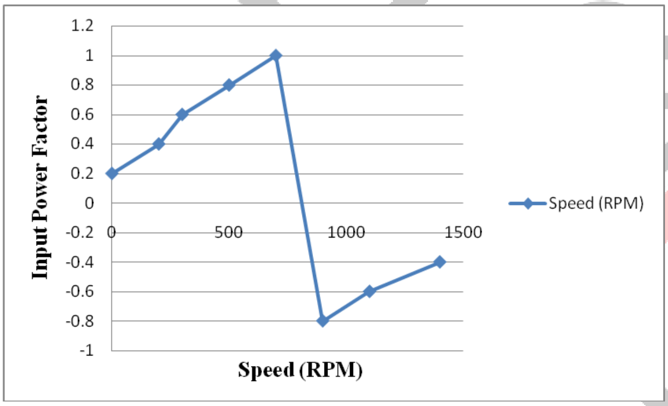
Fig. 2-d. Mode 4 : Free Wheeling Mode – Negative half cycle

In this mode, Current circulates in the motor and parallel connected capacitor C_{fw} in the same direction as it was in mode 3 shows in fig. 2(d). This mode is called as Free Wheeling Mode for Negative half cycle.

Mode 3 and mode 4 are repeated number of times in Negative half cycle. The number of switching intervals depends on applied switching frequency.

IV. SIMULATION RESULT

The simulation results in fig. 3 are the improvement in the input power factor with the Speed in rpm which gives 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.



V. CONCLUSION

In this case of the proposed drives, CosΘ is higher as compared to conventional drive. Therefore stator current 'i' will be lower as compared to conventional drive and the proposed drive is to operate at higher power factor and higher efficiency.

VI. ACKNOWLEDGMENT

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