Enhacing the Power Quality and Performance of Induction Motor Drive

Sayyad Naimuddin, Komal Ambhorkar, Dr. D. R.Tutakne

Abstract— VVVF drives are widely used for speed control of induction motor in many Industries. Phase angle voltage controlled technique is mostly implied for soft start of induction motor however it suffers from drawbacks like retardation of the firing angle which causes lagging power factor at the input side especially at lower speed. In this paper, a new variable voltage control technique is proposed which uses only two high frequency PWM controllable switches for speed control of Induction motor .This method will be suitable for fan, pump and blower load coupled to a single phase induction motor which is used in almost all industries. The advantages of proposed method are its high power factor, high efficiency and less power consumption.The control technique used is easy and convenient. The technique used is economical and can be used in domestic and industrial Applications.

Index Terms— *A variable voltage control scheme, High frequency PWM pulses, high power factor, single phase induction motor, VVVF drive*
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1 INTRODUCTION

Induction motors are simple and rugged in construction, are relatively economical and require little maintenance. Hence, induction motors are preferred in most of the industrial applications such as in Lathes, Drilling machines, Lifts, Cranes, Conveyors etc. Induction motor are most widely used in almost all industries. The speed control of such motors can be achieved by controlling the applied voltage on the motor by the use of power electronic devices [1]. AC voltage controllers as power converters are also used as induction motor soft starter. But this suffers from several drawbacks like retardation of firing angle, poor input power factor, complex control techniques and large no of switches.[2-3]

Induction motors are used for Induced and Forced draft fans, blowers and pumps in industries. e VVVF drives are used for speed control of such motors but the controlled techniques used in VVVF drive is complex and costly [2-3]. AC voltage controllers as power converters used in many application.. Efficiency of power system controlled by some advanced methods in power converters is very important which covers supply and load power factor, harmonic distortion at both supply and load side. One of these advanced methods that is best used is the conventional controller,with phase angle control and it is a known method in contolling AC voltage applied to specific loads.

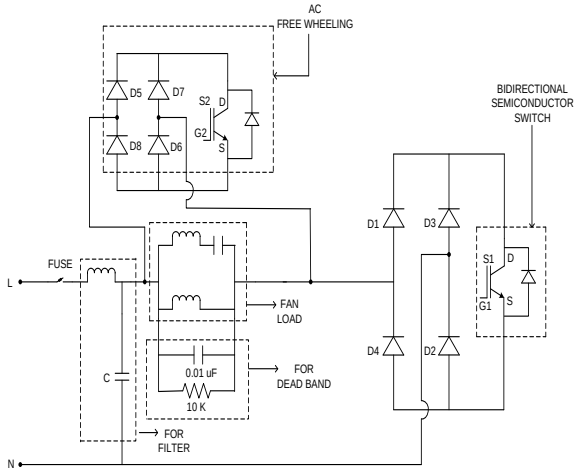
However, these controllers are found to create some problems whose main problems are introduction of high level low order harmonics in current at the load and supply side, poor supply power factor and also low efficiency.

A variable voltage control scheme is proposed in this paper employing with two high frequency PWM controllable switches instead of using more switches. 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 input power factor, high converter efficiency and only two controlled power semiconductor switches. This gives the simple control technique and speed conrol with power saving. The control technique is based on high frequency PWM technique which is more efficient and simpler to implement as compare to control techniques used in VVVF drive and any other induction motor control techniques.

2 CIRCUIT DETAIL AND OPERATION

2.1 Circuit Details

The power circuit is the main circuit providing power (with a controlled voltage) to the single phase Induction Motor. The voltage control employed for the speed control of motor is obtained by controlling the conduction time of a Power MOSFET. The figure below shows the schematic of the power circuit.



POWER CIRCUIT

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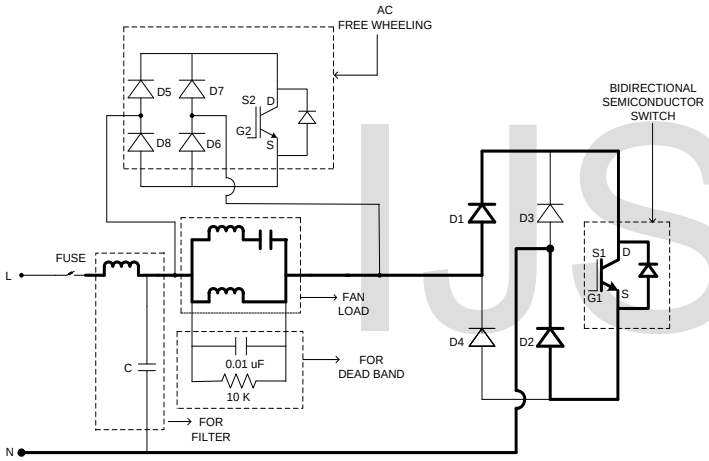
2.2 Operation of Circuit

A single phase Induction motor is supplied with 230V, 50 Hz AC input and the rectifier along with bidirectional power semiconductor swith is controlling the power input to the motor by using control signals. The bridge connects to the drain terminal of the MOSFET, while the negative end connects to source. The other end of the motor terminal and the diode cathode is joined to the source terminal of MOSFET. The pulses generated through the control circuit feed the gate of MOSFET to control its conduction period.

The power flow through the motor winding via MOSFET can be explained in two modes as follows:

2.3 Mode 1: D1 & D2 ON

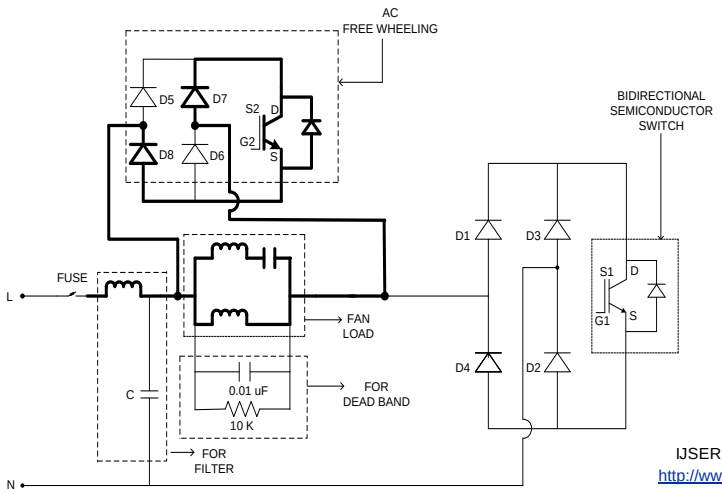
During positive half of supply cycle, MOSFET (S1) is kept on from 0 to π-β. As a result load motor draws power from the source and inductor gets positively charged.The power feed to to the motor is controlled by the operation of the switch S1. Till the time switch is ON power is taken by motor .



MODE 1

2.4 Mode 1: D7 & D8 ON

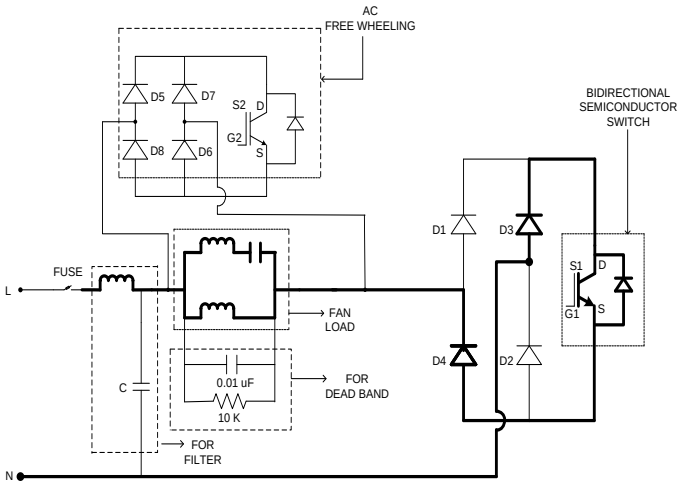
At π-β, S1 is switched off and inductive load reverses its polarity. Power semiconductor switch S2 is triggered and biased and free-wheeling becomes possible through D7 and D8. The load current remains in same direction.



AC FREE WHEELING MODE 1

2.5 MODE 2-: D3 & D4 ON

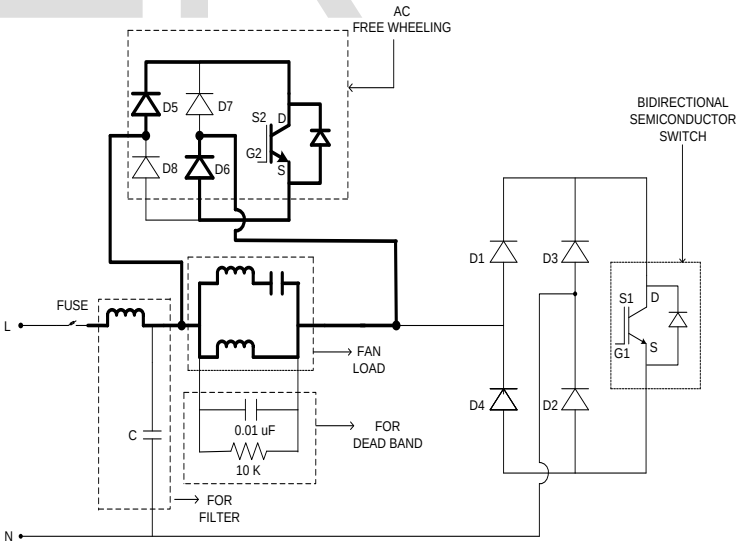
During negative half cycle of applied Ac input , from π to 2π-β the MOSFET (S1) is kept on as a result load draws power from the source and inductor gets charged.



MODE 2

2.6 MODE 2-: D5 & D6 ON

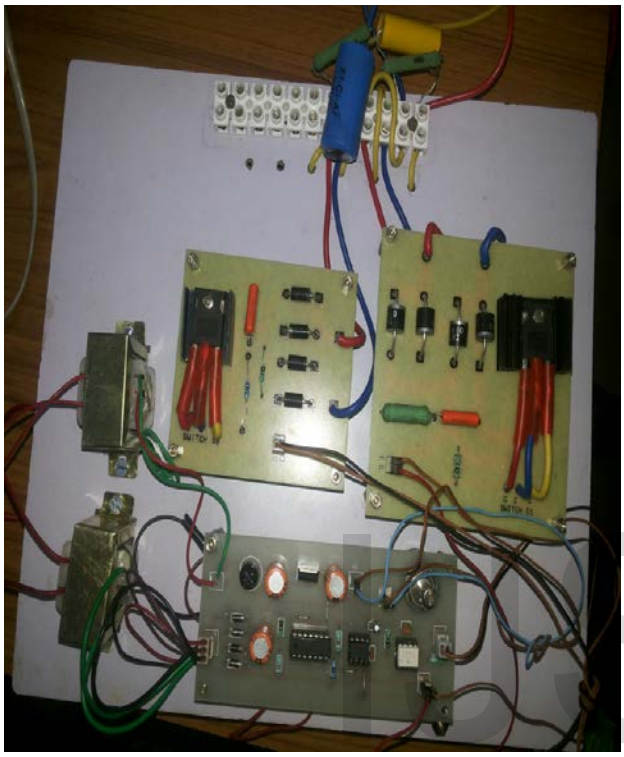
At 2π-β, S1 is switched off and swich S2 is triggered as inductive load reverses its polarity through D5 and D6 and free-wheeling action becomes possible.As the value of β is increased the power factor becomes leading



AC FREE WHEELING MODE 2

3 EXPERIMENTAL SETUP

This section presents the performance evaluation of the proposed scheme with the high frequency PWM technique.The hardware of the proposed work is prepared and tested to obtain the desired result. The complete model for soft starting and speed control of induction motor using MOSFET is shown in Figure. The circuit parameters are shown in table I



3.1 Experimental Readings

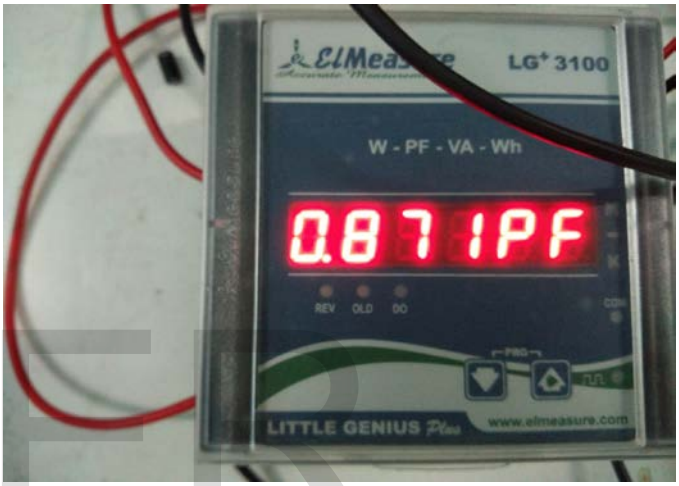
The reading of speed, power factor and power consumption has been taken by varying the extinction angle. The readings obtained from the model are shown in Table I.

SN	EXTINCTION ANGLE (DEGREE)	SPEED (RPM)	POWER FACTOR	POWER (WATT)
1.	81	404.9	0.871(leading)	6.37
2.	72	534	0.914(leading)	7.51
3.	54	1102	0.999 leading)	12.11
4.	36	1182	0.94(lagging)	15.98
5.	18	1206	0.9(lagging)	21.75

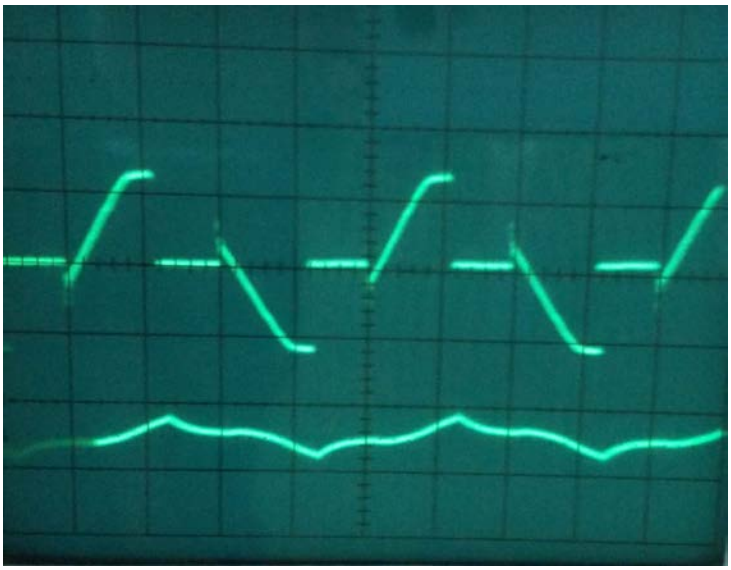
TABLE I : EXPERIMENTAL RESULT

4 RESULTS

The result obtained from the model are shown in fig 4.1,fig 4.2 and in fig- 4.3. The supply power factor becomes leading because of extinction angle control method of speed control, which would be useful to compensate for existing lagging power factor loads.The results obtained from the developed model are showing leading power factor which is highly required for maintaining power system stability and for saving the system losses because of deteoriated power factor. The power consumed by the Induction motor fan load is very small compared to other conventional methods.



4.1 POWER FACTOR METER SHOWS 0.871 LEADING PF



4.2 VOLTAGE AND CURRENT WAVEFORM AT POWER FACTOR 0.871 (leading)

4.3 SPEED AT POWER FACTOR 0.871(leading)

5 CONCLUSION

The wide range of speed control is possible with leading power factor and less power consumption using the proposed scheme. With proposed scheme the motor performance is improved with less noise as compared to conventional drives, EMI radiation and interference are eliminated. Reduced voltage stress with longer life & reliability of motor is possible. The developed scheme is very useful for domestic as well as industrial application.
This method is very simple and less expensive than those of conventional thyristors phase control method. The speed control of an AC motor over a wide range can be implemented by using a power MOSFET circuit. This makes this scheme immensely useful in the modern day Industrial drive control.

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