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AC-AC Conversion with Improved Power factor for Efficient Control of Induction Motor Drive

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Abstract: ***This paper present proposed scheme of AC-AC drive for speed control of Induction Motor. The technique proposed gives leading input power factor. The devices are turned on at zero crossing and turned off at desired instant in every half cycle. In this scheme the drive can operate in entire range of controllable speed and torque unlike conventional phase angle control scheme. The additional advantage in this method is that supply current from AC source becomes leading. The triggering technique of Power electronic devices is opposite to that of firing angle control. The motor voltage is controllable in the entire range from zero to full voltage. The proposed scheme is very useful for various Industrial Applications like Fans, blowers, pumps, Paper mills, textile mills, rolling mills and many more.***

Keywords: A variable voltage control scheme, High frequency PWM pulses, single phase induction motor, VVVF drive.

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]

AC voltage converters are widely used as one of the power electronic device to control output AC voltage in which a variable AC voltage is obtained from fixed AC voltage for power ranges from few watts to fractions of megawatt. Phase angle control (PAC) line commutated voltage controllers and integral cycle control of thyristors have been extensively employed in this type of regulators for many applications. Such techniques offer some advantages as simplicity and the ability of controlling large amount of power economically.

But this technique suffer from inherent disadvantages such as retardation of firing angle causing lagging power factor at the input side especially at large firing angles and high content of lower order harmonics at both, load and supply side. Moreover, there is discontinuity of power flow at both input and output side.

Power factor and displacement factor decreases as the output voltage decreases (firing angle increases).

2. Conventional Methods of Motor Control

AC voltage converters are widely used for the power electronic device to control output AC. Phase angle control (PAC), line commutated voltage controllers and integral cycle control technique of thyristors have been extensively employed in this type of regulators for many applications. This technique suffer from inherent disadvantages such as

1) High $\frac{dv}{dt}$ across the motor.
2) Low Power Factor.
3) High Reactive power consumed.
4) Torque pulsation due to discontinuous current at lower speed.
5) High filtering requirement, high weight of passive components & volume.
6) Higher % of harmonics at low speed operation of motor.

3. Circuit Description

3.1 Extinction Angle Control

In this technique instead of controlling firing delay angle (phase angle), the extinction angle is controlled using forced commutation as shown in fig.3.1 In extinction angle control (EAC), the switch S1 is turned on at $\omega t = 0$ and is turned off by forced commutation at $\omega t = \pi - \beta$ where β is an extinction angle

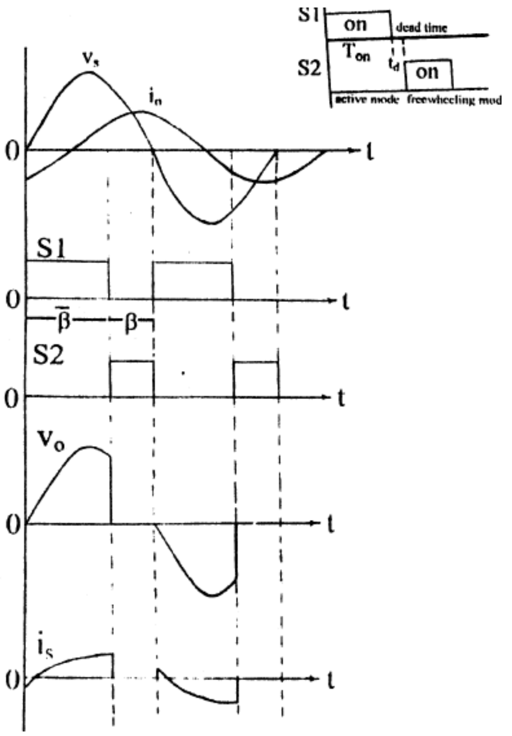

Figure 3.1: waveforms for extinction angle control

From the current waveform it is clear that the fundamental component of input current leads the input voltage Vs. Therefore the displacement factor and power factor are leading thus even though the load is inductive it appears to be capacitive. The (EAC) technique may be used to simulate a capacitive load and to compensate for line voltage drops[1]-[2].

3.2 Proposed Drive Circuit

The power circuit is the main circuit providing power with a controlled voltage to AC Motor. The voltage control employed for the speed control of motor is obtained by controlling the conduction time of a Power MOSFET. The figure 3.2 below shows the schematic of the power circuit designed

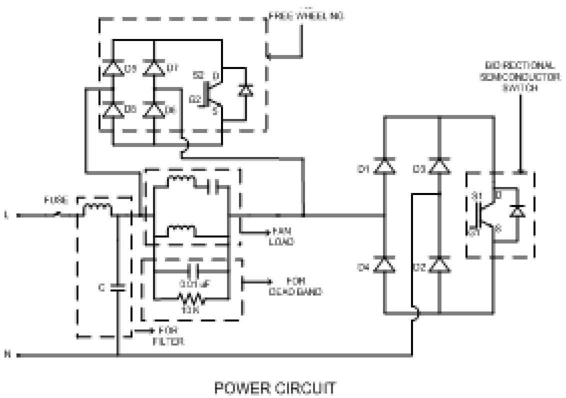

Figure 3.2: Power Circuit of Proposed Drive

3.3 Operation of Circuit

During positive half of supply cycle, MOSFET (S1) is kept on from 0 to π-β. As a result load draws power from the source and inductor gets positively charged. At π-β, S1 is switched off and inductive load reverses its polarity and D7 and D8 are forward biased hence S2 is switched on and free-wheeling becomes possible. The load current remains in same direction. The use of freewheeling switch results in continuous power flow through the motor even when the power is drawn intermittently from the source. It also helps in improving the input power factor and the load current waveform is improved. As a result the load performance is better.

3.4 Circuit Parameters

The delay angle is measured from zero crossing of voltage waveform and is generally termed as (α). Thus the voltage is quantified as

Table 1: Simulation Parameter

Parameter	Value
Maximum supply voltage	325V
Supply frequency	50Hz
Switching frequency	100Hz
β	60^0
Load resistance	47Ω
Load inductance	26.5mH

3.5 Simulation Model

This section presents the performance evaluation of the single phase AC-AC voltage converter with EAC technique by simulation using MATLAB Simulink. The complete simulation model is shown in fig 3.5 The load is taken as a simple R-L load. Simulation is carried out to determine input current, load voltage and load current for both R-L load. Table I shows the simulated circuit parameters for the proposed scheme.

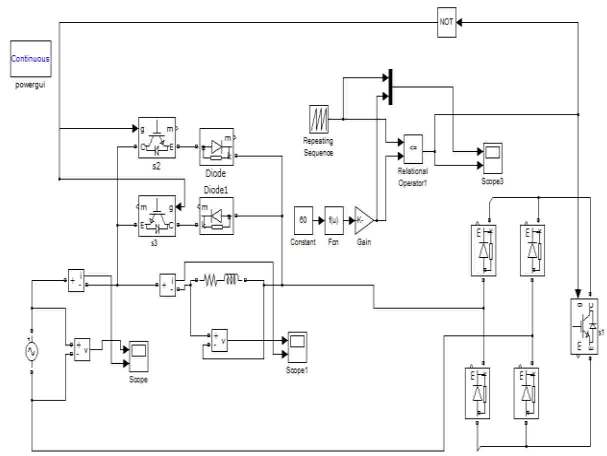

Figure 3.5: Simulink model

4. Simulation Results

The results that have been obtained from the simulation model are presented in this section. Fig. 4.1 shows the voltage and current operating waveforms of the load voltage ,load currents and supply current at $\beta = 60^o$

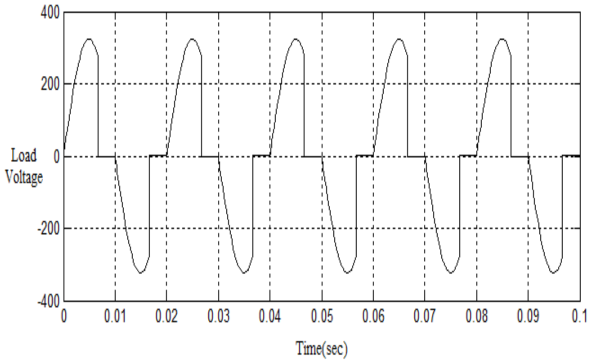

Figure 4.1: Output load voltage

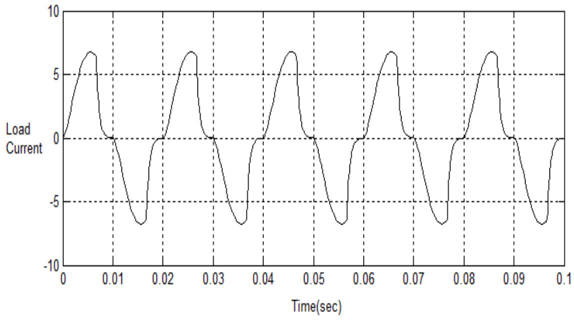

Figure 4.2: Output load Current

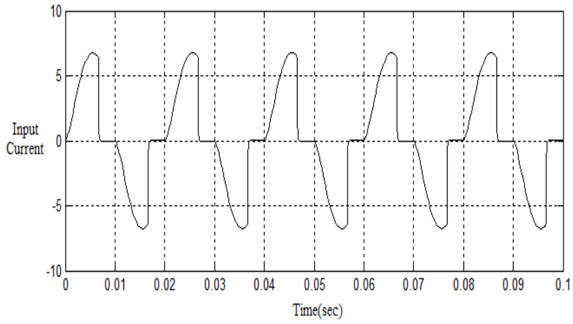

Figure 4.3: Supply Current

5. Conclusions

The paper presents the extinction angle control technique for single phase AC-AC voltage converters. The extinction angle control technique provides a considerable improvement in the input power factor. This improvement is mainly due to the improvement in the displacement factor.

The ac voltage controller with the extinction angle control technique has been applied to a RL load and various results are obtained. Thus, this technique is suitable for most Industrial application like lathes, fans, blowers, pumps and many other where speed control of single-phase induction motor is required. This method is very simple, convenient and cost effective.

6. Acknowledgement

We are thankful to all the members who are directly and indirectly involved in executing our work.

References

[1] Ahmed NA, El-Zohri EH (2003). "Power factor improvement of single phase ac voltage controller employing extinction angle control technique," IEEE conf. Proc. MWSCAS 3: 1075-1080.

[2] Saracoglu, B.; Kale, M.; Ozdemir, E." A novel technique for optimal efficiency control of induction motor fed by PWM IGBT ac chopper" IEEE conf. Proc. PESC 04, pp.3353 – 3358, 2004

[3] Ahmed, N.A.; Mivatake. M.; Hyun Woo Lee; Nakaoka, M." A Novel Circuit Topology of Three phase Direct AC-AC PWM Voltage Regulator", Industry Applications Conference, 2006. 41st IAS Annual Meeting. Conference Record of the 2006 IEEE, vol 4, no., pp.2076,2081

[4] Bilal Saracoglu." Supply power factor and load current harmonic performance improvement of three phase AC voltage controller," Scientific Research and Essays,4 may 2006, Vol. 5(9), pp. 862-868

[5] Eltamaly AM, Alolah AI, Hamouda RM."Performance evaluation of three-phase induction motor under different ac voltage control strategies, Part I," Electrical Machines and Power Electronics, ACEMP '07. International Aegean, Conference, pp. 770-774. Bodrum- Turkey.

[6] Bose, U.; Divya, K.; Jyothi, V.; Sreejith, S." Performance analysis of four-switch three-phase inverter-fed induction motor drive", Power and Energy Systems Conference Towards Sustainable Energy, March 2014, , vol. 2,Issue 3, pp.1,6.

[7] Khushboo Arora, Vivek Saxena, Sanjeev Saini." A Comparative Study and Analysis of Power Factor Correction Methods", International Journal of Emerging Technology and Advanced Engineering, May 2014, Volume 4, Issue 5

[8] A-R A. M. Makky, G. M. Abdel-Rahim, and N. A. Ahmed, "A Novel DC Chopper Drive for Single-Phase Induction Motors," IEEE Trans.Ind. Electron. vol. 42, no. 1, pp. 33-39, Feb. 1995.

[9] Nabil A. Ahmed, K. Amei and M. Sakui, "A New Configuration of Single-Phase Symmetrical PWM AC Chopper Voltage Controller," IEEE Trans. Ind. Electron., vol. 46, no. 5, pp. 942-952, Oct. 1999.

[10] Nabil A. Ahmed, Kenji Amei and Masaaki Sakui, "AC Chopper Voltage Controller-Fed Single-Phase Induction Motor Employing Symmetrical PWM Control Technique," Electrical Power Systems Research Journal, Vol. 55, no. 1, pp. 15-25, July 2000.

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