MICROPROCESSOR BASED PWM INVERTER SYSTEM AND ITS USE FOR CONTROL OF INDUCTION MOTOR

By

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Certificate

Certified that the thesis entitled "Microprocessor Based PWM Inverter System And Its Use For Control Of Induction Motor", which is being submitted by Mehran Motamed Ektessabi in fulfilment for the award of the Degree of Doctor of Philosophy in Electrical Engineering of the Indian Institute of Technology, Delhi, (India), is a record of the student's own work carried out by him under our joint supervision and guidance. The matter embodied in this dissertation has not been submitted for the award of any other Degree or Diploma.

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ABSTRACT

Dedicated digital control techniques for three-phase PWM inverter used for AC drives have been reported in this thesis. In order to illustrate the advantages of the digital PWM technique over that of analog technique, a ROM based controller for three-phase PWM inverter has been designed and developed. In this controller the preformed look-up tables containing firing instants of the inverter SCRs are stored in an EPROM for constant V/f (constant torque) operation upto the rated 5Ø Hz frequency, and constant Horse-Power operation above this frequency with constant input voltage at its rated value. The range of frequency control of this modulator is designed to be from 5 Hz to 75 Hz, in Steps of 5 Hz each. Based on this technique a modulator for a 5Ø Hz, 1 KVA Uninterrupted Power Supply (UPS) has also been designed and fabricated.

Since the microprocessor based modulators for PWM inverter systems are more flexible because of their ability to use the software programs, a new strategy very simple and versatile in nature, has been proposed in this thesis. This New Strategy named as Modified Natural Sampling (MNS) has been implemented using a very simple eight bit microprocessor so as to illustrate its simplicity. The newly proposed technique uses only

integer arithmetic for development of its software, thereby avoiding the problem of using a coprocessor. The technique obviates the solution of complex transcendental equations as is normally the case with Natural Sampling technique.

A vivid study of the harmonic contents using the main frame computer (ICL-2960) for the proposed technique and the other commonly used microprocessor techniques such as Regular Symmetrical Sampling (RSS), Regular Asymmetrical Sampling (RAS), and Modified Regular Sampling (MRS) is done. This comparison as reported in the thesis demonstrates the advantages of the proposed strategy over the other existing strategies.

Next a thyristor based 10 KVA three-phase auxiliary impulse commutated inverter based on pole voltage modulation has also been designed and developed for the experimental purpose.

Through suitable softwares developed and implemented using the proposed microprocessor based modulator, it is possible to obtain an independent control of the inverter output voltage and frequency so as to achieve four different modes of operation; such as Fixed-Voltage Fixed-Frequency (FVFF), Variable-Voltage Fixed-Frequency (VVFF), Fixed-Voltage Variable-Frequency (FVVF), as well as

Variable-Voltage Variable-Frequency (VVVF). These operations along with the other flexibilities as provided by the proposed PWM technique paved the way to have a more flexible AC drive system. The existing microprocessor based PWM techniques published so far, have their own unique merits and demerits, but the MNS based system reported in this thesis provides the advantages listed as under:

1) Simplicity for the microprocessor implementation of the MNS modulator.
2) Lesser hardware requirement, and hence a better reliability.
3) Lesser memory size requirement.
4) Lower harmonic contents as compared to the other microprocessor based PWM techniques.
5) Use of only integer arithmetic, and avoiding the solution of transcendental equations make the method suitable for any kind of simple microprocessor systems.
6) Easy reversal of Induction Motor phase sequence is possible through software.
7) Flexibility to synchronise the reference and the carrier signals to any desired point, so as to obtain the desired output voltage waveform at low carrier ratios ($I<6$) is also possible.

8) Prediction of locus of circular flux in an induction motor fed by MNS inverter is possible.

9) Software based generation of optimum value of commutational delay in MNS modulator causes higher magnitude of fundamental output voltage.

10) Since the commutational delay in MNS modulator can be set to its optimum value, the generation of narrower PWM pulses is possible.

11) The MNS modulator is a universal one and can be used with a variety of power devices with different ratings.

12) The different types of inverter operation such as FVFF, VVVF, VVFF, and FVVF are also possible.

13) Soft-start and soft-stop operations of induction motor fed by MNS inverter can be easily achieved.

The experimental investigations made on the ROM based as well as MNS based inverter systems reported in this thesis have yielded encouraging results in terms of harmonic contents in the output voltage, level of fundamental output voltage for the same value of the modulation index, and overall control of inverter system as compared to the existing systems already published. It is hoped that the newly suggested strategy will be accepted in industry for application in control AC drives.

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CHAPTER-7

MNS MODULATOR USED FOR CONTROL OF INDUCTION MOTOR

CHAPTER-8

CONCLUSION AND FURTHER EXTENSIONS OF THE WORK