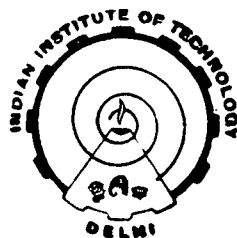


APPLICATIONS OF PERSONAL COMPUTER TO A CHOPPER FED DC MOTOR

by
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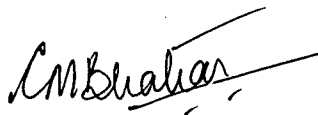
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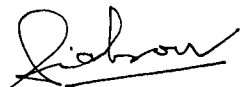
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CERTIFICATE

This is to certify that the thesis entitled, "APPLICATIONS OF PERSONAL COMPUTER TO A CHOPPER FED DC MOTOR" being submitted by Mr. T.M. George, to the Indian Institute of Technology, Delhi (India), for the award of the Degree of Doctor of Philosophy in Electrical Engineering, is a record of bonafide research work he has carried out under our supervision and guidance. The matter embodied in this dissertation has not been submitted to any other University or Institute for the award of a degree or diploma.



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(T.M.George)

ABSTRACT

Microcomputer based control of electric drives is playing a significant role in an automated industry. Earlier analog controllers were used, which are nowadays replaced by digital controllers because the later offer many advantages such as reduction in hardware cost, better reliability, capability to handle sophisticated control functions and flexibility in software control. With the advent of microcomputers, a great momentum as well as a new dimension have been added to the computerised control of drives. Today, the motion control technology is passing through a new era embracing more and more diverse disciplines such as power semiconductor devices, converter circuits, control theory and microcomputers along with the electric machinery.

As one of its major objectives, the work reported in this thesis attempts to extend the concept of workstation to the field of electric drives. Since the Personal Computer (PC) offers many advantages such as good computing power, excellent software support, wide availability of peripherals etc., a computing environment has been developed for a DC drive by upgrading an IBM compatible PC. The workstation developed in the laboratory enables the design of controllers, prediction of system performance, and on-line implementation of control schemes. It also

provides graphic facility, for the visual evaluation of the system performance.

A 5 hp DC shunt motor, with the field winding being separately excited, has been considered for investigation. The motor is coupled to a three phase alternator for the purpose of loading. A two phase impulse commutated chopper has been designed and fabricated in the laboratory. The input to the chopper is from a DC generator and the output is fed to the armature winding of the motor under test. Suitable circuits have been developed to interface the drive with the workstation.

Mathematical expressions, describing the steady state behaviour of the chopper fed motor for the duty, commutation and freewheeling intervals of operation, taking into account the effect of source inductance and also the non-linearity of the magnetic circuit have been written. An LC output filter has been designed to limit the ripple content in the output current and voltage waveforms. Software is written in Turbo Pascal to predict the behaviour of the system, in which the differential equations are numerically solved using Runge-Kutta fourth order method. The performance of the motor is evaluated with the following chopper configurations :

1. Single-phase chopper
2. Single-phase chopper with LC filter

3. Two-phase chopper

4. Two-phase chopper with LC filter

The predicted performance is next verified experimentally for all the four cases mentioned above. A soft start of the machine is achieved by gradually incrementing the the duty-ratio of the chopper through software. The torque-speed characteristics of the motor have been obtained in all the four cases at different values of duty-ratio. Experimental investigations reveal that the performance with two phase chopper using LC filter is very close to that obtained from the DC mains supply.

Research in the past several years shows that the theory of variable structure systems (VSS) provides a powerful approach to control system synthesis. By introducing sliding mode into the system, it is possible to achieve stabilization, disturbance rejection and low sensitivity to plant parameter variation. In this thesis, the basic theory of variable structure systems is presented and different methods of constructing discontinuity surfaces also have been described. In order to minimize chattering, the VSS control is replaced by a high gain feedback control at the vicinity of the sliding plane.

The DC motor is modelled in the state space form and the hyperplane is designed based on the geometric approach. The potentials of LOTUS 1-2-3 spreadsheet program have been

exploited for the design of sliding mode controller. A menu driven macro has been developed to design the hyperplane. Another macro is written to evaluate the performance of the motor control system. The system performance has been predicted for different cases such as step changes in speed as well as torque and system parameter variations, at different speed and load conditions.

The sliding mode controller which is designed has been practically implemented using the workstation. For an effective user interaction the software for the real-time implementation has been developed partly in Turbo pascal, through which the reference values, switching vector matrix etc., are keyed in and the rest in Assembly language. The program is organised in such a way that immediately after the execution, the monitor displays the various performance curves. A fairly good transient behavior has been exhibited by the motor with the sliding mode controller. The sensitivity to parameter variations as well as to external disturbances has been observed to be good. A close agreement is observed between the predicted and experimental results.

Besides the research work stated as above, the thesis also includes proper background material, review and suggestion for further work in this area.

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