Ain Shams University
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Microprocessor Controlled DC Motor Supplied from a GTO-Thyristor Converter

A Thesis

Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Science in Electrical Engineering

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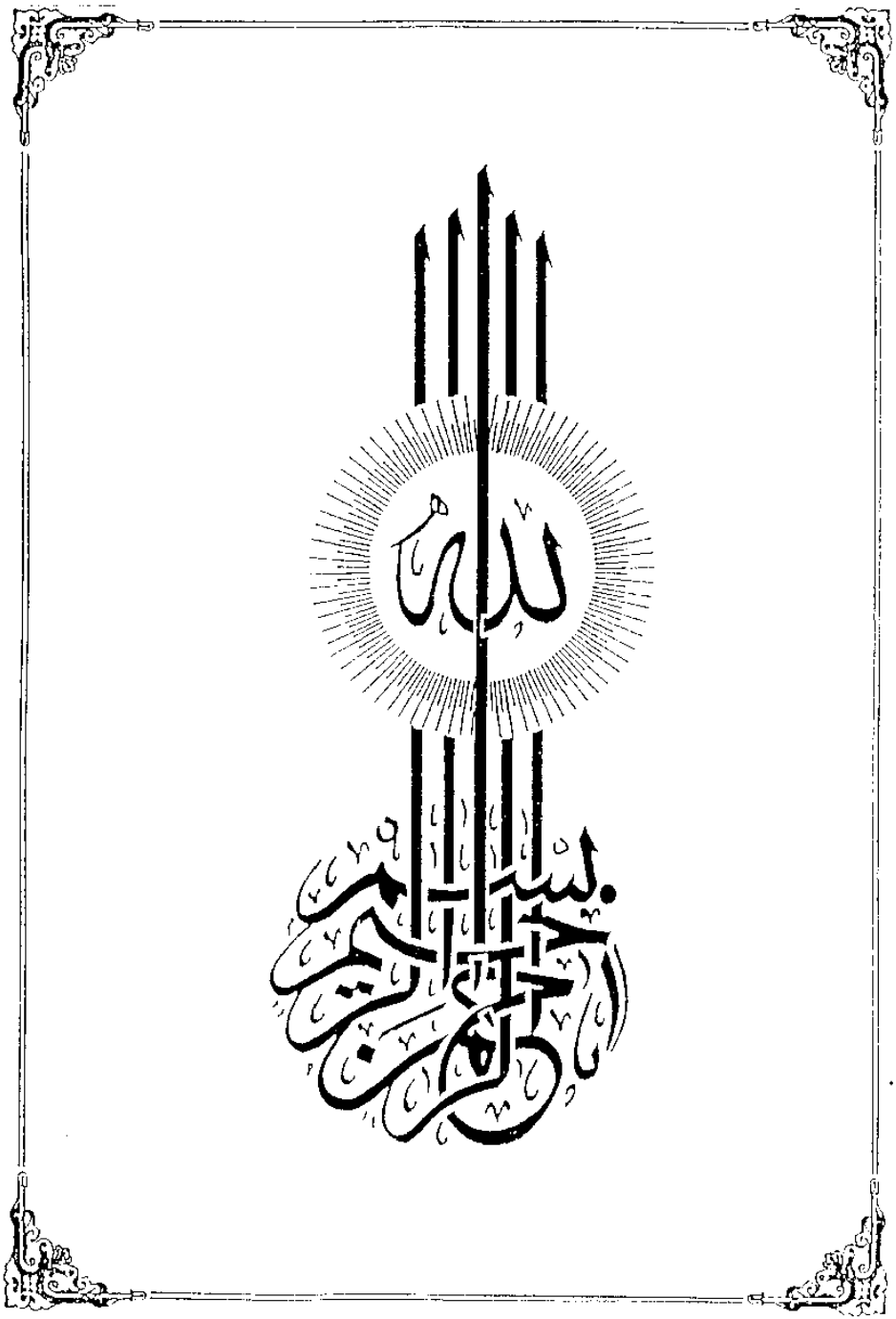

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Statement

This dissertation is submitted to Ain Shames University in partial fulfillment of the requirements for the degree of master of science in Electrical Engineering.

The work included in this Thesis was carried out by the author in the Department of Electrical Power and Machines from Nov. 1990 to 1995.

No part of this thesis has been submitted for a degree or a qualification at any other University or Institution.

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List of Symbols

Symbol	Description
B	Friction Coefficient.
E_a	Armature voltage.
E_b	Back emf.
f	Frequency.
G	Gain of the PWM GTO converter.
I_a	Armature current.
I_f	Field current.
I_o	Initial armature current.
I_p	Primary current.
I_s	Secondary current.
$I_a(t)$	Instantaneous armature current.
I(o)	The current at zero-time.
J	Moment of inertia.
K	Back emf constant.
K_i	Gain of linearization loop
K_i'	Current transducer constant (volt/amp).
$1/K_{2i}$	Gain of current control loop.
L_a	Armature inductance.
L_f	Field inductance.
n	Motor speed in r.p.m.
n_o	Initial motor speed.
n(t)	Instantaneous motor speed.
n(0)	The speed of the motor at zero-time.
R_a	Armature resistance.
R_f	Field resistance.
T	Chopping period.

Symbol	Description
T_{on}	On-time period.
T_{off}	Off-time period.
T_{em}	Electromechanical time constant.
T_L	Load torque.
V_a, V_b, V_c	Phase voltage.
V_{ab}, V_{bc}, V_{ca}	Line to line voltage.
V_c	Input dc voltage to the firing circuit.
V_{cr}	Triangular carrier signal.
V_{dc}	Output dc voltage of the converter.
V_{max}	Peak value of the supply phase voltage.
V_m	r.m.s. voltage.
V_{ms}	Modulating signal.
V_L	Load voltage.
V_s	Secondary Voltage.
V_P	Most positive phase voltage.
V_N	Most negative phase voltage.
V_{PN}	Most positive line to line voltage.
α	Firing angle of the thyristor.
β	Extinction angle of the thyristor.
α_{on}	On-angle of the GTO thyristor.
α_{off}	Off-angle of the GTO thyristor.
τ_a	Electrical time Constant.
τ_l	Time constant of linearization loop.
τ_i	Time constant of current control loop.
τ_m	Mechanical time Constant.
ω	Angular Speed (rad/sec).

Summary

The use of adjustable speed dc motor drives is used in industrial utility and many processes. The versatile control of characteristics of dc motors have contributed to their extensive use in industry.

This Thesis presents the design and testing of a microprocessor controlled separately excited dc motor supplied from a PWM GTO-thyristor converter. The three-phase GTO thyristor converter employing PWM scheme has been found to offer better overall performance than the phase control. The motor speed is controlled by adjusting the armature voltage by PWM GTO thyristor converter. The closed loop system for speed control of dc motors is designed and tested by using three-series loops techniques for the speed and current control.

The Thesis contains seven Chapters as follows :

Chapter one contains an introduction to the history of dc drives and the different types of converters. Chapter two discusses the features of GTO thyristor and different types of its gate drive circuits. The indirect gate drive circuit for wide frequency range application, used in this work, is explained in details.

In Chapter three, the bridge converter is discussed. The one-quadrant six-GTO thyristor bridge converter and its protections are explained in details. The different types of PWM schemes for the converter is discussed. The EPWM scheme, used in this work, is explained in details.

In Chapter four, converter-dc motor drive system is designed and tested, where the speed control of the system has been achieved by using 8088 microprocessor control. A software program was developed to generate the on-time periods of the converter in the proper sequence, which is synchronized with the supply frequency. The torque and speed characteristics of the motor are simulated at different on-time periods and different loading conditions.

Chapter five presents a mathematical analysis for the converter-dc motor drive system and the performance of the drive system has been studied for continuous and discontinuous armature current operations.

In Chapter six, the closed loop control system is studied and designed. The three series loops techniques are used for implementing speed and current controllers, which give good performance for the speed control of the dc motor drive system. The details of the required software and hardware for the closed loop control system are described. The improvement of the motor transient performance in the closed loop operation is clearly shown from the experimental results.

The conclusions are introduced in Chapter seven.

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