TRANSIENT ANALYSIS OF A 3-PHASE ELECTRONIC POWER INVERTER SUPPLYING AN INDUCTION MOTOR

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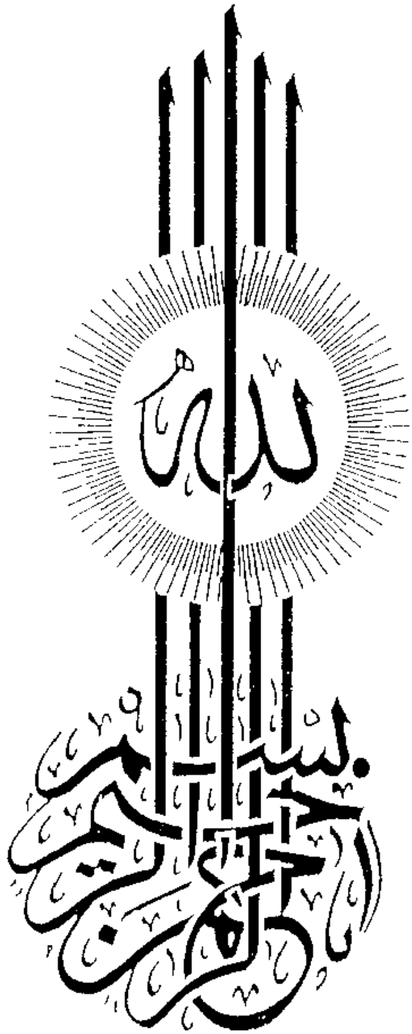
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CONTENTS

S U M M A R Y

The research presented deals with a reliable and efficient solid-state inverter system loaded by an induction motor. Experimental investigation as well as theoretical analysis of the system have been carried out.

A d.c. link converter has been designed and executed in the laboratory. The firing circuit has been specially constructed, it delivers hard drive pulses having a frequency which can be smoothly varied from about 15 to 200 HZ. The frequency variation is achieved by using a astable multivibrator. Frequency variation can be simply done by means of a potentiometer. This astable multivibrator is thermally stable and is not affected by load transients. Thyristor protection against high dV/dt as well as high di/dt and over-current have been taken into consideration.

Oscillograms of the different variables in the system under investigation have been recorded. Extensive tests were performed for different circuit conditions under steady and transient states. Effect of the variation of circuit parameters upon the system behaviour is also studied.

Mathematical analysis of the basic circuit as well as of the modified circuit has been introduced. The mathematical expressions obtained yields a simplified digital computer model. The analysis is concerned with single phase as well as with three-phase inverter circuits.

Digital computer simulation of the system has been executed. Three programs are presented for the three different cases which have been tackled. These are, the basic circuit with passive loads, the single-phase inverter loaded by a single phase induction motor, and the three-phase inverter-motor set. The numerical solution has been carried out on the ICL 1900 series computer of Cairo University. The program can execute six different operations. These are, the starting condition, the steady state performance, the speed torque characteristics, the step variation in torque, the step variation in frequency, and the sudden opening in the load terminals. In the solution of the system, a good method has been adopted which avoids the divergence in the solution of differential equations. However, maximum saving for the computer running and storage times have been considered.

A comparison between the drive system used and other drive systems is performed. As a conclusion, the new soft commutation, variable frequency, relatively good output waveform, high immunity to load disturbances, great flexibility of loads, fast reaction capability and transient free performance of the inverter circuit used make it more suitable to supply induction motors. This type of induction motor drive has speed control and transient performance characteristics which are superior to those of a d.c. motor supplied by a Ward-Leonard set.

The Thesis consists of six chapters. Chapter I is an introduction, it contains the previous literature of the subject. Chapter II deals with the laboratory work. Chapter III and IV are devoted to the mathematical analysis of the system and the digital computer simulation models. The experimental as well as the digital results are given in Chapter V. Chapter VI contains the conclusion.

Appendix I contains lists of the Fortran Programs and samples of results.

Appendix II discusses the method adopted for the solution of differential equations and some examples.

LIST OF SYMBOLS

e, v	voltages
E_d	d.c. supply voltage
e_L	output voltage from single phase inverter
e_1, e_2, e_3	output voltages from the 3-phase inverter
E_s	resultant stator voltage vector
Eds. Eqs	the direct and quadrature components of E_s
ED, EQ	the direct and quarature components of the rotor voltage vector
Vd1,.. Vd6	feedback diode voltages
E_{Ld}	the commutating inductance voltage
i	current
i_{Ld}	the current in the commutating inductance from the thyristors side terminal
id	the d.c. supply current
$id_1 \ldots id_6$	the current through feedback diodes
i_L	output current of the single phase inverter
i_1, i_2, i_3	output phase currents from the 3-phase inverter
I_s	stator current vector
ids, iqs	the direct and quadrature components of I_s

i_{DR}, i_{QR}	the direct and quadrature component of the rotor voltage vector
i_o	zero sequence component of stator current
RID	RMS value of the dc supply current
RIL	RMS value of the stator current.
Ψ	Flux
Ψ_d, Ψ_q	The direct and quadrature flux linkage vectors.
R	Resistance.
R_s, R_r	Stator and rotor windings resistances respectively.
R_2	Resistance of the starting winding of the single phase induction motor.
RQ	Quadrature axis rotor resistance of the single phase motor.
L	Inductance.
sm	Main inductance per phase of the 3-phase induction motor.
Lm	3-phase main inductance
L	Leakage inductance of induction motor
t	time
W	angular speed mean value

w_m	rotor angular speed in elec. rad./sec.
w_s	rotor synchronous angular speed in elec. rad./sec.
M	Torque
M_e	electrical torque in NM
M_m	Mechanical torque in NM.
	Co-officient of friction NM.sec^2/elec.rad.
J	moment of inertia of the moving parts NM sec./elec.rad.
B	Number of pairs of poles
Tor	electric torque mean value.