IMPLEMENTATION OF AN ECONOMICAL MULTIFUNCTIONAL DIGITAL RELAY FOR THREE PHASE INDUCTION MOTORS

By

Eng. Mohamed Ahmed Ahmed Elsayed

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
In

ELECTRICAL POWER AND MACHINE ENGINEERING

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Under the Supervision of

Prof. Dr**. Essam eldin M. Abo elzahaab**

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Title of Thesis: IMPLEMENTATION OF AN ECONOMICAL MULTIFUNCTIONAL DIGITAL RELAY FOR THREE PHASE INDUCTION MOTORS

Key Words: **(protection relay; Digital ; Intelligent ; 3 phase induction motor)**

Summary:

This thesis presents an integrated, economical, actual, and industrial multifunction digital relay MDR1 to be used in the protection of three phase induction motor. Possible faults are studied with their causes. Recommended protective functions are presented and implemented using micro-controller 8951. Flowcharts for each routine for each function are implemented with corresponding software programs. Nine functions were designed and implemented inside the relay MDR1 and these functions are protection against over and under current, over and under voltage, unbalanced currents and voltages, over temperature of windings, and earth fault protection.

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NOMENCLATURE

ANSI	American National Standard Institute
ALE	Address Latch Enable
CSA	Canadian standard administration
CUw1	Loss in Stator
CUw2	Loss in Rotor
CT	Current Transformer
CPU	Central Processing Unit
DOL	Direct-On-Line
DPH	Data Pointer high
DPL	Data Pointer Low
DPTR	Data Pointer 16b
DIL	Dual In Line
EPRI	Electrical Power Research Institute
EA	Enable All
E	Induced electromotive force
EF	Earth Fault
E_n	Nominal voltage
EPROM	Electrical Programmable Read Only Memory
FLP	Accuracy limit factor
IEC	International Electrical Commission
I_{min}	Minimum phase current
I_{max}	Maximum phase current
I_N	Full load current
I_{start}	Root mean square value of staring current
I_{pstart}	Peak value of starting current
IEEE	Institute of Electrical and Electronic Engineers
I_n	Reference (base) current
I_{max}	Maximum phase current
I/O	Input/Output
I_E	Earth fault
I_{residu}	Residual current
I_{En}	Nominal Residual current
K	Multiplier factor
Lu	Under voltage
MDR1	Motor Digital Relay one
NEMA	National Electrical Manufacturers Association
Oc	Over current

Ou	Over voltage
Oc°	Over temperature
PL	Phase Loss
PSW	Program Status Word
PC	Program Counter
PCB	Printed Circuit Board
RPM	Revolution per Minuit
ROM	Read Only Memory
RAM	Random Access Memory
ST	The start setting
SFR	Special Function Register
SCON	Serial CON registers
SBUF	Serial Buffer registers
SPDT	Single Pole Double Through
$T_{rise,unb}$	Higher temperatures due to voltage unbalance
$T_{rise,rated}$	The maximum temperature rating of insulation that can be acceptable
T_{start}	Maximum starting time of motor
TH0	Timer High
TL0	Timer Low
TMOD	Timer MOD registers
TCON	Timer CON registers
T	Over current trip time
UI	Unbalanced current
Uc	Under current
Uu	Unbalanced voltage
VUF	Voltage Unbalance Factor
V_{avg}	Average voltage
V_n	Negative sequence voltage
V_P	Positive sequence voltage
VT	Voltage Transformer
Vo	Output voltage
V_{min}	Minimum phase voltage
V_{max}	Maximum phase voltage
V_N	Full load voltage
W1	Input to Motor
Wo	Iron Loss
W2	Input to Rotor
W_{ST}	Stray Load Loss
W_{RR}	Power in Rotating Field
W_{DEV}	Power Developed