



Cairo University

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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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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TABLE OF CONTENTS

	Page
ACKNOWLEDGMENT	i
TABLE OF CONENTS	ii
LIST OF TABLES	vii
LIST OF FIGURES	viii
NOMENCLATURE	x
ABSTRACT	xiii
CHAPTER 1: INTRODUCTION	
1.1 Introduction	1
1.2 Thesis objectives	1
1.3 Thesis outlines	1
CHAPTER 2: ABNORMAL CONDITIONS ON THE THREE PHASE INDUCTION MOTOR	
2.1 Introduction	3
2.2 Under voltage	3
2.2.1 Effect of under voltage on the motor efficiency, RPM, and current	3
2.2.2 Causes of under voltage	4
2.3 Over voltage	4
2.4 Unbalanced voltage and current	5
2.4.1 Voltage unbalance factor	5
2.4.2 Causes of unbalanced voltage conditions	6
2.4.3 Single phasing and causes of single phasing condition	6
2.5 Loss of load or (under current)	7
2.6 Frequency variation	7
2.7 Mechanical jam	7

CHAPTER 3: **THREE PHASE INDUCTION MOTOR PROTECTION FUNCTIONS**

3.1	Introduction	8
3.2	Thermal motor protection	8
3.2.1	Thermal protection with temperature sensors	10
3.2.2	Thermal protection with current sensing	11
3.2.2.1	Electromechanical over current relay	11
3.2.2.2	Electronic overload relays	11
3.3	single phase and line unbalance protection	12
3.4	start/stall protection	13
3.4.1	Number of starts limitation	14
3.5	Short circuit protection	15
3.6	Ground fault protection	15
3.6.1	Zero sequence CT connection	16
3.6.2	Residual ground fault connection	16
3.7	Under & over voltage protection	17
3.8	Under current (loss of load) protection	17

CHAPTER 4: **GENERAL CONSTRUCTION OF THE PROPOSED MULTIFUNCTION DIGITAL RELAY MDR1**

4.1	Introduction	18
4.2	General structure of the system	18
4.2.1	Proposed Microcontroller ATM89S51	19
4.2.1.1	Microcontroller comparison with human	19
4.2.1.2	Microcontroller definitions	19
4.2.1.3	Basic features of micro ATM89S51	19
4.2.1.4	Pin assignment	20
4.2.1.5	Memory map	20
4.2.2	Proposed analog to digital converter ADC0804	21
4.2.3	Seven segment display interfacing and programming	22
4.2.4	Relay output circuit	24
4.2.5	Proposed temperature measurement sensor	25
4.2.6	Current and voltage sensors (CT&VT)	25
4.2.7	Current and voltage measurement circuits (interfacing)	25
4.2.7.1	Current measurement circuit	26
4.2.7.2	Voltage measurement circuit	26

CHAPTER 5: **MDR1 RELAY PROTECTION FUNCTION**

5.1	Introduction	30
5.2	Unbalance protection system	31
5.2.1	Proposed hardware	32

5.2.2	Proposed software of the system	33
5.3	Over, under, and single phasing protection system	34
5.3.1	Proposed hardware	35
5.3.2	Proposed software of the system	35
5.4	Over and under current protection system	38
5.4.1	Proposed hardware	38
5.4.2	Proposed software of the system	39
5.5	Over temperature and earth fault pro. System	43
5.5.1	Proposed hardware	43
5.5.2	Proposed software of the system	44
5.6	Display system	47
5.6.1	Proposed hardware	47
5.6.2	Proposed software of the display system	48
5.7	Power supply system	51
5.7.1	The main power supply circuit	51
5.7.2	Over current delay timer circuit	52
5.7.3	Residual current measuring circuit	52
5.7.4	The reset relays	52

CHAPTER 6: **MDR1 SPECIFICATIONS**

6.1	General	53
6.2	Input circuits	53
6.2.1	Auxiliary power supply	53
6.2.2	Phase current inputs	53
6.2.3	Residual current inputs	53
6.2.4	Voltage inputs	53
6.2.5	Temperature LM35 input	53
6.3	Output circuits	53
6.3.1	Output relays	53
6.3.2	Display	53
6.4	Protective function settings	53
6.4.1	Under current settings -37	53
6.4.2	Phase over current settings -50/51	54
6.4.3	Phase unbalance current settings -46	54
6.4.4	Phase unbalanced voltage settings -46	54
6.4.5	Over voltage settings -59	54
6.4.6	Under voltage settings -27	54
6.4.7	Over temperature setting	54
6.4.8	Earth fault settings -50N/51N	54
6.4.9	Phase loss settings	54
6.5	MGF1 layout and dimension	55

CHAPTER 7: **EXPERIMENTAL IMPLEMENTATION AND RESULTS ANALYSIS**

7.1	Introduction	57
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7.2	Over current inverse curve results	57
7.3	%Under current and it's trip time	58
7.4	%Unbalance current and its trip time	59
7.5	%Unbalance voltage and its trip time	59
7.6	%Over voltage and it's trip time	60
7.7	%Under voltage and it's trip time	61
7.8	Maximum temperature	61
7.9	Earth fault and its trip time	61

CHAPTER 8: TECHNICAL EVALUATION AND ECONOMICAL MERITES OF THE PROPOSED MDR1 RELAY

8.1	Introduction	63
8.2	Technical advantages of the MDR1 multifunction relay	63
8.3	Disadvantages of MDR1 digital multifunction relay	64
8.4	Economical advantages of MDR1 multifunction relay	64
8.4.1	Cost of unbalance protection system	65
8.4.2	Cost of over and under current protection system	65
8.4.3	Cost of over and under voltage protection system	66
8.4.4	Cost of over temperature and earth fault pro. System	67
8.4.5	Cost of voltage measuring and interface system	67
8.4.6	Cost of current measuring and interface system	67
8.4.7	Cost of the display system	68
8.4.8	Cost of power supply system	68
8.4.9	The total cost of the system	69
8.4.10	Comparison between the price of the MDR1 and other Similar relays in the market	70

CHAPTER 9: CONCLUSIONS 73

REFERENCES 74

APPENDIX A: SFR AND INSTRUCTION SET

A.1	SFR (Special Function Register)	76
A.2	Instruction set	77

APPENDIX B: LM35 FEATURES 79

APPENDIX C: UNBALANCE SYSTEM

C.1	Schematic diagram	80
C.2	PCB (Printed Circuit Board)	81
C.3	Unbalance assembly program	82

APPENDIX D: OVER, UNDER VOLTAGE, AND SINGLE PHASING SYSTEM

D.1	Schematic diagram	84
D.2	PCB (Printed Circuit Board)	85

D.3	Over, under voltage, and single assembly program	86
APPENDIX E: OVER AND ANDER CURRENT SYSTEM		
E.1	Schematic diagram	88
E.2	PCB (Printed Circuit Board)	89
E.3	Over and under current assembly program	90
APPENDIX F: OVER TEMP. AND EARTH FAULT SYSTEM		
F.1	Schematic diagram	92
F.2	PCB (Printed Circuit Board)	93
F.3	Over temperature and earth fault assembly program	94
APPENDIX G: DISPLAY SYSTEM		
G.1	Schematic diagram	96
G.2	PCB (Printed Circuit Board)	97
G.3	Display assembly program	98
APPENDIX H: POWER SUPPLY SYSTEM		
H.1	Schematic diagram	99
H.2	PCB (Printed Circuit Board)	100
APPENDIX I: VOLTAGE AND CURRENT MEASURING SYSTEM		
I.1	PCB (Printed Circuit Board) of voltage measurement	101
I.2	PCB (Printed Circuit Board) of current measurement	102

LIST OF TABLES

- 1- Table 2.1: Percentage of load reduction with voltage unbalance
- 2- Table 3.1 : summary of IEEE and EPRI Motor reliability surveys
- 3- Table 5.1: over current inverse characteristic curves
- 4- Table 7.1: over current inverse characteristic results calculated and actual
- 5- Table 7.2: % under current setting and maximum error
- 6- Table 7.3: %und. cur. trip time error values
- 7- Table 7.4: %Unbalanced current setting and maximum error
- 8- Table 7.5: %Unb. Cur. trip time error values
- 9- Table 7.6: %Unbalance voltage settings and maximum error
- 10- Table 7.7: %Unb. Voltage trip time error values
- 11- Table 7.8: %Over voltage settings and maximum error
- 12- Table 7.9: %over volt. trip time error values
- 13- Table 7.10: %Under voltage settings and maximum error
- 14- Table 7.11: %Und. Volt. trip time error values
- 15- Table 7.12: Maximum temperature settings and maximum error
- 16- Table 7.13: Earth fault settings and maximum error
- 17- Table 7.14: EF trip time error values
- 18-Table 8.1: Cost of unbalance protection system
- 19-Table 8.2: Cost of over and under current protection system
- 20-Table 8.3: Cost of over and under voltage protection system
- 21-Table 8.4: Cost of over temperature and earth fault system
- 22-Table 8.5: Cost of voltage measuring system
- 23-Table 8.6: Cost of current measuring system
- 24- Table 8.7: Cost of display system
- 25- Table 8.8: Cost power supply system
- 26- Table 8.9: Total cost of the relay
- 27- Table 8.10: Comparison between MDR1 and Yueqing Aukeman relay
- 28- Table 8.11: Comparison between MDR1 and SEL-710 relay
- 29- Table 8.12: Comparison between MDR1 and (ABB) REM543 relay

LIST OF FIGURES

- 1- Figure 2.1: Voltage variation effects on motor performance
- 2- Figure 2.2 :Example of voltage surge
- 3- Figure 2.3 :De-rating factor from NEMA MG1
- 4- Figure 3.1 :Distribution of losses in motor
- 5- Figure 3.2 : Positive and negative sequence components
- 6- Figure 3.3: Lifetime of motor depending on operating current
- 7- Figure 3.4 :Insulation resistance & temperature
- 8- Figure 3.5 :Transistor temperature sensor
- 9- Figure 3.6 : Stall protection
- 10- Figure 3.7 :Number of starts without exceeding maximum temperature
- 11- Figure 3.8 :Zero sequence CT connection
- 12- Figure 3.9 :Residual ground fault connection
- 13- Figure 4.1 :General construction of the system MDR1
- 14- Figure 4.2 :Pin assignment for ATMEL89S51
- 15- Figure 4.3 :Memory map
- 16- Figure 4.4 :The sequence of instruction operation
- 17- Figure 4.5 :Pin diagram of ADC0804
- 18- Figure 4.6 :7-Segment display
- 19- Figure 4.7 :Pin diagram
- 20- Figure 4.8 :Common anode and common cathode seven segments
- 21- Figure 4.9 :Relaying output circuit
- 22- Figure 4.10: LM35 connection
- 23- Figure 4.11 :Schematic diagram of current measuring interface circuit
- 24- Figure 4.12 :Voltage measuring interface circuit
- 25- Figure 5.1 :Protection functions of MDR1 multifunction relay
- 26- Figure 5.2 :Block diagram of unbalance protection system
- 27- Figure 5.3 :RESET circuit for the microcontroller ATM89S51
- 28- Figure 5.4 :Clock circuit for the microcontroller ATM89S51
- 29- Figure 5.5 :The flowchart of the unbalance voltage or current
- 30- Figure 5.6 :Block diagram of the over/under voltage protection system
- 31- Figure 5.7 :Flow chart of the over and under voltage protection system
- 32- Figure 5.8 :Block diagram of the over/under current protection system
- 33- Figure 5.9 :The flow chart of the over/under current protection system
- 34- Figure 5.10: The inverse characteristic curves for over current protection system
- 35- Figure 5.11 :Block diagram of the over temperature and earth fault protection system
- 36- Figure 5.12 :The flow chart of the over temperature and earth fault system
- 37- Figure 5.13 :Operation of the motor after cooling

- 38- Figure 5.14 :The lockout relay
- 39- Figure 5.15 :The flow chart of the display system
- 40- Figure 6.1 :The MDR1 internal layout
- 41- Figure 6.2 :External layout
- 42- Figure 6.3 :MDR1 dimensions
- 43- Figure 7.1 :Comparison between the calculated and actual inverse curves
- 44- Figure B.1 :Pin diagram for LM35

- 45-Figure C.1 : Unbalance voltage or current
- 46- Figure C.2 : The printed circuit board (PCB) of the unbalance system
- 47- Figure D.1 : Schematic diagram of over, under voltage, and single phasing system
- 48- Figure D.2 : The printed circuit board (PCB) of the Over, under voltage, and single phasing system
- 49- Figure E.1: Over and under current system
- 50- Figure E.2: The printed circuit board (PCB) of the over and under current system
- 51- Figure F.1: The schematic of the over temperature and earth fault system
- 52- Figure F.2: The printed circuit board (PCB) of the over temperature and earth fault system
- 53- Figure G.1: Schematic diagram of the display system
- 54- Figure G.2: The printed circuit board (PCB) of the display system
- 55- Figure H.1: The schematic diagram of the power supply system
- 56- Figure H.2 : PCB of the power supply system
- 57- Figure I.1: PCB of the voltage measurement circuit
- 58- Figure I.2: PCB of the current measurement circuit

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 starting 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