

**ELECTRICAL AUTOMATION  
SYSTEMS TOWARDS INTELLIGENT  
AND ENERGY EFFICIENCY  
APPLICATIONS**

---

Musse Mohamud Ahmed



IIUM PRESS

INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA

**ELECTRICAL AUTOMATION SYSTEMS**  
**TOWARDS**  
**INTELLIGENT AND ENERGY EFFICIENCY**  
**APPLICATIONS**

**Musse Mohamud Ahmed**

Electrical and Computer Engineering Department,  
The Faculty of Engineering, IIUM



**IIUM Press**

Published by:  
IIUM Press  
International Islamic University Malaysia

First Edition, 2011  
© IIUM Press, IIUM

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without any prior written permission of the publisher.

Perpustakaan Negara Malaysia

Cataloguing-in-Publication Data

ISBN: 978-967-418-170-3

Member of Majlis Penerbitan Ilmiah Malaysia – MAPIM  
(Malaysian Scholarly Publishing Council)

Printed by :  
**IIUM PRINTING SDN.BHD.**  
No. 1, Jalan Industri Batu Caves 1/3  
Taman Perindustrian Batu Caves  
Batu Caves Centre Point  
68100 Batu Caves  
Selangor Darul Ehsan  
Tel: +603-6188 1542 / 44 / 45 Fax: +603-6188 1543  
EMAIL: [iiumprinting@yahoo.com](mailto:iiumprinting@yahoo.com)

## CONTENTS OF THE BOOK

<u>Chapter</u>	<u>Title &amp; Author</u>	<u>Page No</u>
<b>PART I: ELECTRICAL DISTRIBUTION AUTOMATION SYSTEMS</b>		
CHAPTER 1:	ELECTRICAL DISTRIBUTION SYSTEM ..... Musse Mohamud Ahmed and Soo Wai Lian	2
CHAPTER 2:	ELECTRIC DISTRIBUTION EQUIPMENT FAULTS..... Musse Mohamud Ahmed and Soo Wai Lian	6
CHAPTER 3:	FAULTS FROM TRADITIONAL TO AUTOMATION TECHNIQUES..... Musse Mohamud Ahmed and Soo Wai Lian	15
CHAPTER 4:	SCADA SYSTEM FOR ELECTRICAL DISTRIBUTION SYSTEM..... Musse Mohamud Ahmed and Soo Wai Lian	22
CHAPTER 5:	SCADA SOFTWARE DEVELOPMENT–INDUSOFT CASE STUDY..... Musse Mohamud Ahmed and Soo Wai Lian	25
CHAPTER 6:	PROTECTION SYSTEM FOR ELECTRICAL DISTRIBUTION..... Musse Mohamud Ahmed and Soo Wai Lian	37
CHAPTER 7:	RELAYS..... Musse Mohamud Ahmed and Soo Wai Lian	43
CHAPTER 8:	REMOTE TERMINAL UNIT (RTU)..... Musse Mohamud Ahmed and Soo Wai Lian	49
CHAPTER 9:	INTELLIGENT AUTOMATION SYSTEM: AUTOMATION HARDWARE DEVELOPMENT Musse Mohamud Ahmed and Soo Wai Lian	60
CHAPTER 10:	SCHEMATIC DIAGRAMS OF AUTOMATED SUBSTATION PANELS..... Musse Mohamud Ahmed and Soo Wai Lian	69
CHAPTER 11:	SOFTWARE AUTOMATION DEVELOPMENT ..... Musse Mohamud Ahmed and Soo Wai Lian	78
CHAPTER 12:	DEVELOPMENT OF MODBUS TCP/IP SETTING ..... Musse Mohamud Ahmed and Soo Wai Lian	87
CHAPTER 13:	POWER LINE CARRIER COMMUNICATION SYSTEM..... Musse Mohamud Ahmed and Soo Wai Lian	96
CHAPTER 14:	WIRELESS COMMUNICATIONS FOR ELECTRIC SYSTEM AUTOMATION..... Othman O. Khalifa and Musse Mohamud Ahmed	103
CHAPTER 15:	DEVELOPMENT OF AUTOMATION SYSTEM FOR SMALL/MEDIUM	

SCALE BIOMASS BASED RENEWABLE POWER PLANTS .....	108
Musse Mohamud Ahmed and Sheroz Khan	

<u>Chapter</u>	<u>Title &amp; Author</u>	<u>Page No</u>
----------------	---------------------------	----------------

**PART II: INTELLIGENT SYSTEMS USING COMMUNICATION AND ELECTRONICS SYSTEMS**

CHAPTER 16:	MODELING OF LOW VOLTAGE POWER LINE FOR DATA COMMUNICATION: SIMULATION RESULTS .....	118
	Amar Hazwani Binti Radzi, Wisatawati Darwis Harahap, Sheroz Khan, Musse Mohamud Ahmed and Khaizuran Abdullah	
CHAPTER 17:	LOW VOLTAGE POWERLINE ANALYSIS AND SIMULATION RESULTS.....	125
	Amar Hazwani Binti Radzi, Wisawati Darwis Harahap, Sheroz Khan, Musse Mohamud Ahmed and Khaizuran Abdullah.	
CHAPTER 18:	ZIGBEE APPLICATIONS TO WIRELESS COMMUNICATION SYSTEMS .....	133
	Hikma Shabani, Musse Mohamud Ahmed, Sheroz Khan and Rashid A. Saeed	
CHAPTER 19:	MODELING OF AN ENVIRONMENT FRIENDLY HYBRID ELECTRIC VEHICLE (HEV).....	138
	Musse Mohamud Ahmed, M. Habib Ullah, Teddy S. Gunawan, M. Raihan Sharif and Riza Muhida	
CHAPTER 20:	PIC 16F877A FOR HYBRID VEHICLE CONTROLLER .....	144
	Musse Mohamud Ahmed, M. Habib Ullah, Teddy S. Gunawan, M. Raihan Sharif, and Riza Muhida	
CHAPTER 21:	FPGA-BASED HARDWARE MODELING OF LIGHT RAIL TRANSIT FARE CARD CONTROLLER .....	155
	Musse Mohamud Ahmed, M. Raihan Sharif and M. Habib Ullah	
CHAPTER 22:	DEVELOPMENT OF A METHOD TO MAINTAIN TEMPERATURE AND HUMIDITY IN AN OPEN COMPOUND RESTAURANT .....	166
	M. Raihan Sharif and M. Habib Ullah, Musse Mohamud Ahmed	

**PART III: ENERGY EFFICIENCY APPLICATIONS TO ELECTRIC MOTORS AND FAN MOTORS**

CHAPTER 23:	ELECTRIC MOTOR .....	176
	Musse Mohamud Ahmed, Noor Zatil Amali Bt Muhammad Hanapi and Che Fazilah Bt Fathil	
CHAPTER 24:	LOSSES OF ELECTRIC MOTORS .....	180
	Musse Mohamud Ahmed, Noor Zatil Amali Bt Muhammad Hanapi and Che Fazilah Bt Fathil	
CHAPTER 25:	ELECTRIC MOTOR EFFICIENCY .....	185
	Musse Mohamud Ahmed, Noor Zatil Amali Bt Muhammad Hanapi	

and Che Fazilah Bt Fathil

CHAPTER 26:	ENERGY EFFICIENCY IMPLEMENTATION OF PERMANENT MAGNET SYNCHRONOUS MOTOR.....	191
	Musse Mohamud Ahmed, Noor Zatil Amali Bt Muhammad Hanapi and Che Fazilah Bt Fathil	

<u>Chapter</u>	<u>Title &amp; Author</u>	<u>Page No</u>
CHAPTER 27:	ENERGY CALCULATIONS.....	195
	Musse Mohamud Ahmed, Noor Zatil Amali Bt Muhammad Hanapi and Che Fazilah Bt Fathil	
CHAPTER 28:	MODELING, RESULT AND ANALYSIS .....	203
	Musse Mohamud Ahmed, Noor Zatil Amali Bt Muhammad Hanapi and Che Fazilah Bt Fathil	
CHAPTER 29:	AIR BLOWING EQUIPMENT .....	210
	Musse Mohamud Ahmed, Rafizah Rahmatullah and Syarifah Nur Zati Abdul Rashid	
CHAPTER 30:	ENERGY USAGE IN MALAYSIA.....	214
	Musse Mohamud Ahmed, Rafizah Rahmatullah and Syarifah Nur Zati Abdul Rashid	
CHAPTER 31:	FAN MOTOR EFFICIENCY REQUIREMENT.....	217
	Musse Mohamud Ahmed, Rafizah Rahmatullah and Syarifah Nur Zati Abdul Rashid	
CHAPTER 32:	APPLICATION OF FAN MOTOR ENEGY EFFICIENCY.....	220
	Musse Mohamud Ahmed, Rafizah Rahmatullah and Syarifah Nur Zati Abdul Rashid	
CHAPTER 33:	FAN EFFICIENCY GRADE (FEG) DEVELOPMENT STAGES.....	223
	Musse Mohamud Ahmed, Rafizah Rahmatullah and Syarifah Nur Zati Abdul Rashid	
CHAPTER 34:	FEG AND FMEG PRACTICAL CONSIDERATIONS - FAN SELECTIONS GUIDE .....	227
	Musse Mohamud Ahmed, Rafizah Rahmatullah and Syarifah Nur Zati Abdul Rashid	
CHAPTER 35:	RESULTS AND DISCUSSIONS.....	232
	Musse Mohamud Ahmed, Rafizah Rahmatullah and Syarifah Nur Zati Abdul Rashid	

## CHAPTER 7

### RELAYS

Musse Mohamud Ahmed and Soo Wai Lian

*Department of Electrical and Computer Engineering, Faculty of Engineering  
International Islamic University Malaysia*

This chapter discusses about relays, over-current and earth leakage current relays, and experimental results on distribution automation system on the relays.

#### 7.1 Relays

Relays are interfaces that control one electrical circuit by opening and closing its contacts in another circuit. Relays are used as interfaces when the output signal from the decision section of the circuit is too small to energize the load or when additional contacts are required. Relays can be electromechanical or solid-state.

An electromechanical relay is a relay with sets of contacts which are closed by magnetic force. Electromechanical relays are limited to switching about 15A but are capable of switching several different circuits simultaneously. An electromechanical relay includes a magnetic coil and contacts.

A coil is wound consisting of insulated conductors arranged to produce magnetic flux. A relay coil causes the contacts to open and close as power is applied field draws the armature into contact with the magnetic core. The contacts open or close when the armature moves. Relays have normally open (NO) contacts, normally closed (NC) contacts, or both. A contact is the conducting part of a switch that operates with another conducting part to make or break a circuit. Figure 7.1 shows conventional relay construction.

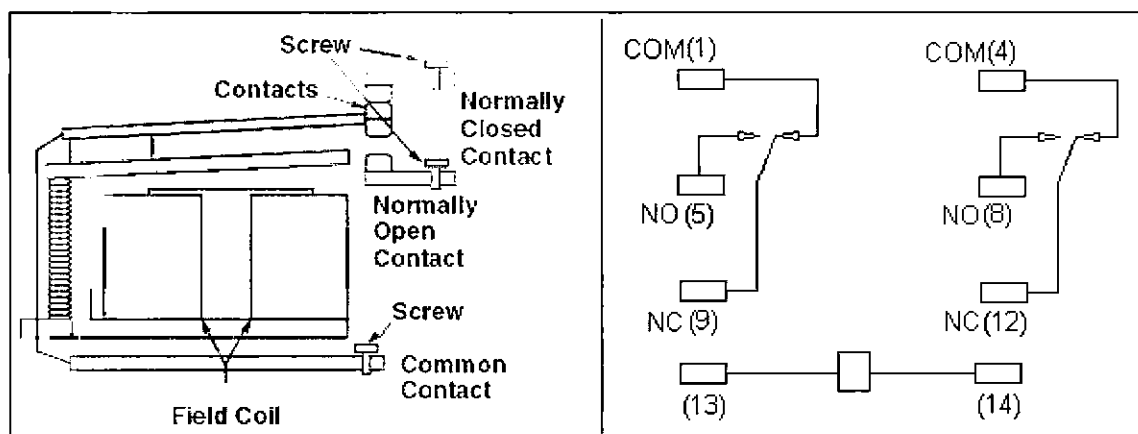


Figure 7.1: Relays Construction