

CONTROL AND OPERATION OF THREE PHASE SYNCHRONOUS MICROGRID



Submitted by:

Muahmmad Faizan	13018019183
Yasir Ilyas	13018019022
Umair Hassan	13018019141
Akbar Zaheer Khan	13018019046

Supervised by:

Nauman Ahmad (Assistant Professor)

**DEPARTMENT OF ELECTRICAL ENGINEERING
SCHOOL OF ENGINEERING
UNIVERSITY OF MANAGEMENT AND TECHNOLOGY,
LAHORE**

ACKNOWLEDGMENT

We sincerely express our deepest sense of gratitude to our mentor and advisor **Mr. Nauman Ahmad** for his direction, support, motivation and invaluable guidance. We would like to give special thanks to our honorable Director of projects **Mr. Jameel Ahmad** for his updates and timely response at different phases of project and thanks to our parents who worked days and night to complete our university dues and who encouraged us every time we would be disappointed. Without their love and support, we would not be able to do this project. We would like to express our sincere thanks and great gratitude to our parents, teachers and the staff of UMT and all labs coordinators for their valuable assistance. Special thanks are due to all group members who cordially assisted in this report.

DECLARATION

We declare that the work contained in this thesis is our own, except where explicitly stated
Otherwise. In addition this work has not been submitted to obtain another degree or
Professional qualification.

Muhammad Faizan

Yasir ilyas

Akbar Zaheer Khan

Umair Hassan

Date: _____

DEDICATED TO

We dedicate our efforts to our respected advisor Sir Nauman Ahmed. He is always there available for any sort of help and guidance when we need it and keep us boost up by telling us different perspectives and alternatives about the technical work. Applause is for all team members, very corporative and hard working to accomplish this research. Moreover we like to extend our dedication to our beloved parents.

CONTENTS

ACKNOWLEDGEMENT	iv
DECLARATION	vi
DEDICATED TO	vii
LIST OF FIGURES	x
LIST OF TABLES	xi
NOMENCLATURE	xii
ABSTRACT	xiii
CHAPTER 1: INTRODUCTION	1
1.1 Background	1
1.2 Objectives	2
1.3 Problem Statement	2
1.4 Report Orientation	3
CHAPTER 2: LITERATURE REVIEW	4
CHAPTER 3: ELECTRICAL MACHINES	6
3.1 DC Motor	6
3.1.1 DC motor types	7
3.1.2 Project DC motor	8
3.2 Synchronous Generator	10
3.2.1 Why Excitation	10
3.2.2 Project Synchronous Generator	11
3.3 Motor Generator Set	12
3.4 Stepper Motor	13
CHAPTER 4: ELECTRONIC, METERING & PROTECTION DEVICES	15
4.1 Drives	15
4.1.1 Why Electrical Drives	16
4.1.2 Classifications of Drives	16
4.1.3 Project DC Drive	16
4.2 Arduino Uno	17
4.3 Emon Tx Shield	19
4.3.1 Why Programmable Emon Tx Metering	20
4.4 Current Sensor	21
4.5 Potential Transformer	22
4.6 Three Phase Circuit Breaker	22
4.7 Single Phase Circuit Breaker	23
4.8 Bus Bar	24

4.9	Load	25
CHAPTER 5:	CENTRAL CONTROLLER	26
5.1	Steppers Interfacing With Arduino	26
5.2	CC Algorithm Developments	27
5.3	Working of Central Controller	30
CHAPTER 6:	MICROGRID OPERATIONS	31
6.1	Operation	31
6.2	Mode of Operations	33
6.2.1	Manual Motor Generator Start on	33
6.2.2	Automatic Motor Generator Start on	34
6.2.3	Frequency Converter	34
6.3	Load conditions	35
6.3.1	No Load Condition	35
6.3.2	Half Load Condition	36
6.3.3	Full load Condition	37
CHAPTER 7:	CONCLUSION & FUTURE WORK	39
7.1	Conclusion	39
7.2	Future work	39
REFERENCES		41
APPENDICES		42
APPENDIX A		42
APPENDIX B		45

List of Figures

Figure	Figure Title	Pages
Figure 3.1	Power flow of Dc motor and generator	6
Figure 3.2	Structure of dc motor	7
Figure 3.3	Project dc shunt motor	9
Figure 3.4	Structure of Synchronous generator	10
Figure 3.5	Project synchronous generator	11
Figure 3.6	Motor Generator set	13
Figure 3.7	Stepper with potentiometer	14
Figure 4.1	Project DC drive	17
Figure 4.2	Arduino Uno	18
Figure 4.3	Emon Tx shield	19
Figure 4.4	Emon Tx shield placement	20
Figure 4.5	Current sensor	21
Figure 4.6	Potential transformer	22
Figure 4.7	Three phase circuit breaker	23
Figure 4.8	Single phase circuit breaker	24
Figure 4.9	Bus bar	24
Figure 4.10	Load connected in star	25
Figure 5.1	Stepper interfacing	27
Figure 5.2	Flow chart of cc algorithm	29
Figure 5.3	Block diagram of cc	30
Figure 6.1	Block diagram of hardware	32
Figure 6.2	Single line diagram of distribution box	35

List of Tables

Table	Table Title	Pages
Table 3.1	Dc motor ratings	9
Table 3.2	Synchronous generator ratings	12
Table 4.1	Specs of Arduino Uno	18

NOMENCLATURE

Symbol	Description
DER	Distributed Energy Resource
DG	Distributed Generator
DC1	First DC motor drive
DC2	Second DC motor drive
MG	Motor generator set
MC	Micro source Controller
CC	Central Controller
PCC	Point of Common Coupling
DCM	DC motor
SM	Synchronous machine
LC	Load Controller
FPC	Federal Power Commission
MIC	Measurement, Information and Control
EPS	Electric Power System
IM	Induction Machine

ABSTRACT:

Control and operation of microgrid is about efficient control and monitoring. The control and operation of microgrid involves the stability of voltage and frequency at generator bus bar. This is achieved by maintaining the field excitation of synchronous generator to have 400V at the bus bar. Likewise, frequency at the bus bar is maintained at 50Hz by controlling the speed of generator. A DC shunt motor has been used, for this purpose, as a prime mover of synchronous generator. Both the speed of DC motor and field of synchronous generator are varied from DC drives. Both the drives are commanded by two Arduino separately. Emon Tx shield interfaced with Arduino is used for metering purpose at the synchronous generator output. A small resistive load box also attached at the output of generator.

Chapter 1

INTRODUCTION

An intelligent control system is designed for the efficient working step by step to meet our desired 400v voltage and frequency of 50 Hz. This is automatic start and control motor generator set. Mainly our generation system consists of DC motor and synchronous generator coupled with each other. We are using two DC drives for speed controlling and to attain desired output. DC1 drive is controlling the speed of DC motor to attain the required RPM (Revolution per minute) speed and DC2 drive is used to control the synchronous machine to attain 400v output voltage to meet the requirement of the load attached. Load box consist of resistive only. For automation we connected stepper motors with DC drives to have a very accurate control of stepper motors according to desired rotation. These stepper motors are interfaced with Arduino and programmed according to the feedback control system.

The feedback control system first checks the RPM speed of DC motor controlled by stepper motor 1 setup and then it checks the 400v output which is attained by controlling exciter voltages controlled by second stepper motor setup. At the same time when our microgrid is running we are showing the system's running status on 16*4 LCD (Liquid crystal display) display showing readings like P (active power), Q (reactive power), Frequency and generator voltage at bus bar.

1.1 Background

The development of the energy and the rise in the number of new consumers of electricity demands a serious need to improve the energy management system in domestic use. We are here to develop an intelligent control for the production units which consist of coupled DC motor and synchronous machine. The system is capable of acquiring the desired parameters by using feedback control signal with Arduino. This will also inform the user about every major step while the system is in running condition. Above all our main aim is to automate the microgrid