

DESIGNING A SIMULATION MODEL OF PHASOR MEASUREMENT UNIT (PMU) USING MATLAB/SIMULINK

BY

ZEESHAN KHURSHID

01-244152-037

SUPERVISED BY

DR. ASAD WAQAR



Session-2015-2017

A Report submitted to the Department of Electrical Engineering

Bahria University, Islamabad

in partial fulfilment of the requirement for the degree of MS(EE)

CERTIFICATE

We accept the work contained in this report as a confirmation to the required standard for the partial fulfilment of the degree of MS(EE).

Head of Department

Supervisor

Internal Examiner

External Examiner

DEDICATION

I dedicate this small piece of effort to my parents & supervisor as well as my colleagues, who encouraged and supported me during whole tenure. Without their support and sincere advises, it could not possible to complete within given time period.

DECLARATION OF AUTHORSHIP

I **Engr. Zeeshan Khurshid # 01-244152-037** hereby declare that content of this thesis is my own work and that it is the result of work done during the period of registration. To the best of my knowledge, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the award of any other degree or diploma of the university or other institute of higher learning, except where due acknowledgement has been made in the text.

Signature of student:

Date: _____

Zeeshan Khurshid
01-244152-037

ACKNOWLEDGEMENTS

Firstly, I want to thank to Allah almighty, as He has provided me the golden opportunity, continual inspiration, intellectual ability and determination to complete my MS degree. With His mighty blessings, He provided whole necessary thing fall on the right time into right place and make a possible me with enormously supportive, cooperative and unexcitable people, mainly during the period of this research work. Therefore, I would like to give my hearty gratitude and thankfulness to these peoples, deprived of whom this achievement would not have been achievable:

The key person, who arises to mind at the idea of this research work, is my supervisor Dr. Asad Waqar for his endless help, inspiration and attentiveness throughout the completion of this research work. His supervision and visions were priceless and his efficient and well-defined approach of working paid a countless deal to the achievement of this research work. I would more like to show my thankfulness to Department Teachers Dr. Amir and Mr. Muneeb Yaqoob for providing their expert opinions for data analysis and psychometric consultations.

This memorable time period cannot be finalized without the inspiration, love and support of my family and friends. These are not sufficient disputes to show my gratefulness to my parents. I similarly extend my thanks to my friends Rizwan Hanif, Saima Gull and Naila Majeed who contributed to my research in all most every manner. I want to direct my gratefulness and warm gratitude to my other delightful friends and classmates who take contributed their best in research process as they can. Thank you all.

ABSTRACT

The electrical power system is becoming more and more complex with the increasing demand of the electricity across the world, as the world is becoming the global village. The electrical power system must be reliable and safe enough to fulfil the energy requirements with the continuous supply of energy. The chances of power system's blackouts and outages are increasing with its increased complexity. So, there is a need of an efficient control system to make the power system more safe, efficient and reliable. Wide area monitoring, protection and control (WAMPAC) system is becoming an emerging technology for an efficient monitoring, protection and control of power system. Phasor measurement unit (PMU) is an integrated part of WAMPAC system, which can be used for monitoring, protection and control of complex electrical power systems. PMU gives the synchronized phasor measurements of voltage and current and can easily monitor and control even small disturbances in power system to protect the power system from any blackouts and outages before any fault occurs. In the proposed research a PMU model is designed in MATLAB/Simulink and then PMU is used for power system protection. The comparative analysis are also done with the conventional protection technique for an interconnected two-area network power system as a case study.

TABLE OF CONTENTS

Certificate.....	ii
Dedication.....	iii
Declaration of Authorship.....	iv
Acknowledgements.....	v
Abstract.....	vi
Table of Contents.....	vii
list of tables.....	xii
Abbreviations.....	xiii
CHAPTER 1. Introduction.....	2
1.1. Background.....	2
1.2. Problem Description.....	4
1.2.1. Wide Area Monitoring System (WAMS).....	5
1.2.2. Phasor Measurement Unit (PMU).....	6
1.3. Thesis Objectives.....	9
1.4. Thesis Organization.....	10
CHAPTER 2. Literature Review.....	12
CHAPTER 3. Methodology.....	18
3.1. Proposed System.....	18

3.2. Simulation model of a Phasor Measurement Unit (PMU).....	19
3.2.1. Working of different Components of PMU	19
3.2.2. Novel Controller	21
CHAPTER 4. Results and Evaluation	24
4.1.1. System Setup.....	24
4.1.2. Electrical Ratings of Simulink Model.....	24
4.2. The Steady State Operation of the proposed Power System (without fault)	25
4.3. The Operation of the proposed Power System with a 3-phase (L-L-L-G) fault.....	27
4.4. The Synchronized Phasor measurements of the Proposed Power System.	29
4.4.1. Results from the Synchronization of PMUs	29
4.4.2. Discussions	30
4.5. The Protection of the Proposed Power System.....	31
4.5.1. Protection by using Phasor Measurement Unit.....	31
4.5.2. Results from the Backup protection with PMU	33
4.5.3. Protection by using Conventional Technique (Analog Scheme).....	35
4.5.4. Results from the Backup protection with Analog Technique	36
4.6. Evaluation:	37
CHAPTER 5. Conclusions and future work.....	40
5.1 Conclusion	40

5.2 Future Works	41
References.....	42

LIST OF FIGURES

Figure 1. Three zones of operation for each standalone relay.	4
Figure 2. A sinusoidal waveform and its phasor representation	6
Figure 3. General PMU structure.....	7
Figure 4. Flowchart of the Controller	22
Figure 5. Two Area Network Power System	24
Figure 6. Area_1 Voltage (p.u).....	25
Figure 7. Area_2 Voltage (p.u).....	26
Figure 8. Load_1 Voltage (p.u).....	26
Figure 9. Load_2 Voltage (p.u).....	26
Figure 10. power System (With a 3-phase fault)	27
Figure 11. Area_1 Voltage (p.u).....	27
Figure 12. Area_2 Voltage (p.u).....	28
Figure 13. Load_1 voltage (p.u)	28
Figure 14. Load_2 Voltage (p.u).....	28
Figure 15. Proposed System with PMUs	29
Figure 16. Power System with PMU	31
Figure 17. Backup power System	32

Figure 18. Power System Backup Protection with PMU.....	33
Figure 19. Area_1 Voltage (p.u).....	33
Figure 20. Area_2 Voltage (p.u).....	34
Figure 21. Load_1 Voltage (p.u).....	34
Figure 22. Load_2 Voltage (p.u).....	35
Figure 23. Power System Backup Protection with Analog technique	35
Figure 24. Area_1 Voltage (p.u).....	36
Figure 25. Area_2 Voltage (p.u).....	36
Figure 26. Load_1 Voltage (p.u).....	37
Figure 27. Load_2 Voltage (p.u).....	37
Figure 28. Comparison of PMU with Conventional Technique	38

LIST OF TABLES

Table 1: The Outp.ut of PMU 1:.....	30
Table 2:T The Outp.ut of PMU 2.....	30