TABLE OF CONTENTS

CONTENTS ..... **vii**

LIST OF TABLES ..... **ix**

LIST OF FIGURES ..... **x**

LIST OF ABBREVIATIONS ..... **xii**

CHAPTER 1 INTRODUCTION 1

1.1 Background 1

1.2 Problems Statement 2

1.3 Objectives 3

1.4 Hypotheses 3

1.5 Research Methodology 3

1.6 Problem Limitation 4

CHAPTER 2 REVIEW OF LITERATURE AND STUDIES 5

2.1 Digital Substation System (DSS) 5

2.1.1 Benefits of digital substations system 6

2.1.2 SAM600 – Process bus IO system 8

2.2 Transformer Protection 9

2.2.1 Transformer Phase Fault 10

2.2.2 Working Principle of Over Current Relay (OCR) and Ground Fault Relay (GFR) 11

2.2.3 Stand By Earth Fault (SBEF) 13

2.2.4 Differential Relay 13

2.2.5 Restricted earth fault (REF) Relay 14

2.3 RET650 (87T/87N) 16

2.3.1 Transformer differential protection (87T) 17

2.3.2 Restricted earth-fault protection, low impedance REFPDIF (87N) 18

CHAPTER 3 DESIGN MODEL AND SYSTEM 20

3.1 Simulation Flow 20

3.2 DSS Baturtaja Arcitecture 22

3.2.1 Station Level 24

3.2.2 Bay Level 25

3.2.3 Process Level 25

CHAPTER 4 RESULT, ANALYSIS, AND REPAIR 27

4.1 Fault Record and Comtrade Result 27

4.2 Visual and Stability Result 29

4.2.1 Visual check result 29

4.2.2 Stability Result 32

4.3 Fault Analysis 34

4.4 Repair and Testing 37

4.4.1 CT Circuit Repair 37

4.4.2 Added function logic block under voltage supervision for REF LV 39

4.4.3 Improvements to the system architecture change over switch pattern GPS 1 and GPS 2 45

CHAPTER 5 CONCLUSION AND FUTURE WORK 47

5.1 Conclusions 47

5.2 Future Work 48

BIBLIOGRAPHY 49