

OPTIMAL LOCATION OF THYRISTOR CONTROLLED
SERIES COMPENSATOR USING SENSITIVITY APPROACH

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To my wonderful family, I love you with all my heart.

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ABSTRACT

The vast development and world globalization had caused the existing power system in most country to hit its bottleneck. In order to sustain the demand, the current power supply will need to be expanded. Due to cost saving from expansion the power system network, the system operator has to allow the system to operate nearer to the system thermal limit and subsequently increase the transmit capacity. The Availability Transfer Capability (ATC) can be increased using Flexible AC Transmission System (FACTS). However, FACTS devices are very expensive and high generation scheduling cost. This project is to focus on how to determine the optimal location to install this expensive FACTS devices. Optimal location of the installation of FACTS devices can be determined using the sensitivity analysis. There are several types of FACTS devices, and Thyristor Controlled Series Capacitors (TCSC) has been selected to use in the project report on account of its overall performance and cost effectiveness to relieve congestion. The scope of this project report will using sensitivity based approach to determine the optimal location of TCSC. MATLAB is used to perform the power flow of the power system and the result is adopted into sensitivity index model. Then the location of the TCSC is determined using the most positive sensitivity index. The simulation is tested using POWERWORLD on chosen 5-bus system, IEEE 14-bus system and also 30-bus system. As a result, the optimal location of TCSC is determined and verified.

ABSTRAK

Pembangunan and globalisasi telah menyebabkan system kuasa yang sedia ada dalam kebanyakan negara mencecah kesesakan. Dalam usaha mengekalkan permintaan, bekalan kuasa perlu dipertingkatkan. Pengendali sistem kuasa perlu membenarkan sistem untuk beroperasi hamper kepada had sistem haba supaya boleh jimat daripada pengembangan rangkaian sistem kuasa, dengan ini keupayaan menghantar kuasa dapat dipertingkatkan. Keupayaan keterdapatan perpindahan boleh ditingkatkan menggunakan Flexible AC Transmission System (FACTS). Walau bagaimanapun, peranti FACTS sangat mahal dan kos generasi tinggi. Projek ini adalah untuk memberi tumpuan kepada bagaimana untuk menentukan lokasi yang optimum untuk memasang peranti FACTS. Lokasi optimum pemasangan alat-alat FACTS boleh ditentukan dengan menggunakan analisis sensitivity. Thyristor Controlled Series Capacitors (TCSC) telah dipilih daripada beberapa jenis peranti FACTS untuk digunakan dalam laporan projek disebabkan oleh prestasi keseluruhan dan keberkesanan kos untuk memberikan kestabilan sementara. Skop laporan projek ini akan menggunakan pendekatan berasaskan sensitivity untuk menentukan lokasi optimum TCSC. MATLAB digunakan untuk melaksanakan aliran kuasa sistem kuasa dan hasilnya dipindahkan ke dalam model indeks sensitivity. Kemudian lokasi TCSC ditentukan menggunakan indeks sensitivity yang paling positif. Simulasi ini dilaksanakan dengan menggunakan POWERWORLD pada sistem 5-bas, IEEE sistem 14-bas dan juga sistem 30-bas. Kesimpulannya, lokasi optimum TCSC ditentukan dan disahkan.

TABLE OF CONTENTS

CHAPTER	TITLE	PAGE
	DECLARATION	iii
	DEDICATION	iv
	ACKNOWLEDGEMENT	v
	ABSTRACT	vi
	ABSTRAK	vii
	LIST OF TABLES	xi
	LIST OF FIGURES	xii
	LIST OF APPENDICES	xiii
1	INTRODUCTION	1
	1.1 Introduction	1
	1.2 Problem Statement	1
	1.3 Objectives	2
	1.4 Scope of Work	2
	1.5 Report Organization	3
2	LITERATURE REVIEW	4
	2.1 Introduction	4
	2.2 FACTS technology	4
	2.3 Brief Modeling of FACTS Controllers	6
	2.3.1 The Thyristor-controlled Reactor	6
	2.3.2 The Static Var Compensator	7
	2.3.3 The Thyristor-controlled Series Compensator	7

2.3.4	The Static Compensator	8
2.3.5	The Solid State Series Compensator	9
2.3.6	The Unified Power Flow Controller	9
2.4	Advantages of TCSC	10
2.5	Sensitivity Approach on TCSC	11
2.6	Other Researchers Works	15
2.6.1	Sensitivity Based Analysis For UPFC	15
2.6.2	Real Power Flow Performance Index Sensitivity Approach For TCSC	15
2.6.3	Loss Sensitivity Indices for SSSC	16
2.7	Summary	16
3	METHODOLOGY	
3.1	Introduction	17
3.2	MATLAB	17
3.3	MATPOWER	18
3.4	POWERWORLD SIMULATOR	20
4	RESULTS AND DISCUSSION	
4.1	Introduction	21
4.2	5-Bus Test System	21
4.2.1	Solution Using Sensitivity Analysis	22
4.2.2	Manual Installation To Other Lines	24
4.2.3	5-Bus System Discussion	25
4.3	IEEE 14-Bus Test System	26
4.3.1	Solution Using Sensitivity Analysis	26
4.3.2	Discussion	30
4.4	IEEE 30-Bus Test System	31
4.4.1	Solution Using Sensitivity Analysis	31
4.4.2	Discussion	34
4.5	Summary	34

5	CONCLUSION AND FUTURE WORKS	35
	5.1 Conclusion	35
	5.2 Future Works	35
	REFERENCES	37-38
	Appendix (A-C)	39-78

LIST OF TABLES

TABLE NO.	TITLE	PAGE
4.1	Sensitivity Coefficient	23
4.2	Simulation Summary	24
4.3	Summary of Result From Installing TCSC at Different Branch	24
4.4	Sensitivity Index For IEEE 14-Bus System	27
4.5	Sensitivity Index Comparing Zone A and Zone B	29
4.6	Sumamry of TCSC Installation in Different Line	30
4.7	Sensitivity Index For IEEE 30-Bus System	32
4.8	Most Sensitive Line In IEEE 30-Bus System	33
4.9	Summary of TCSC Installation in Different Line In IEEE 30-Bus System	34

LIST OF FIGURES

FIGURE NO.	TITLE	PAGE
2.1	Family Tree of FACTS Devices	5
2.2	Model of TCR	6
2.3	Model of the SVC	7
2.4	Model of TCSC	8
2.5	Model of STATCOM	8
2.6	Model of SSSC	9
2.7	Model of UPFC	10
2.8	Model of transmission line with TCSC	11
2.9	Injection Model of TCSC	11
2.10	Flow Chart for Proposed Method in Effective Location of TCSC	13
2.11	Operating Range of a TCSC (Solid Lines) and allowed regions for the reactance (bold lines)	14
4.1	5-Bus Test System	22
4.2	IEEE 14-Bus Test System	26
4.3	Power Flow Concentrated in Zone A of IEEE 14-Bus System	28
4.4	IEEE 30-Bus System	30

LIST OF APPENDICES

APPENDIX	TITLE	PAGE
A.1	MATLAB M-file For 5-Bus System	40
A.2	MATPOWER RESULT OF POWERFLOW	41
A.3	POWERWORLD With 5-Bus System	42
A.4	20% of TCSC in 5-Bus System	42
A.5	65% of TCSC in 5-Bus System	43
A.6	20% TCSC at line 1-2 in 5-Bus System	43
A.7	20% TCSC at line 2-3 in 5-Bus system	44
A.8	20% TCSC at line 1-4 in 5-Bus system	44
A.9	20% TCSC at line 2-5 in 5-Bus system	45
A.10	20% TCSC at line 3-5 in 5-Bus system	45
B.1	IEEE 30-BUS Common Data Format	46
B.2	MATLAB M-file of 14-Bus IEEE System	48
B.3	MATPOWER Power Flow Output of 14-Bus IEEE System Page 1	50
B.4	MATPOWER Power Flow Output of 14-Bus IEEE System Page 2	51
B.5	IEEE 14-Bus System in POWERWORLD	52
B.6	IEEE 14-Bus System in POWERWORLD With 70MVA Line Limit	53
B.7	20% of TCSC Installed in Bus 12 to Bus 13	54
B.8	20% TCSC Installed in Bus 3 to Bus 4	55

B.9	IEEE 14-Bus With 20% TCSC On Line 1 (Bus 1 to Bus 2)	56
B.10	IEEE 14-Bus With 20% TCSC On Line 2 (Bus 1 to Bus 5)	57
B.11	IEEE 14-Bus With 20% TCSC On Line 5 (Bus 2 to Bus 5)	58
B.12	IEEE 14-Bus With 20% TCSC On Line 4 (Bus 2 to Bus 4)	59
B.13	IEEE 14-Bus With 20% TCSC On Line 7 (Bus 5 to Bus 4)	60
C.1	IEEE 30-BUS Common Data Format	61
C.2	MATLAB M-file of IEEE 30-Bus System	64
C.3	MATPOWER Power Flow Output of IEEE 30-Bus System	67
C.4	IEEE 30-Bus System in Power World Simulator	70
C.5	IEEE 30-Bus System With 80MVA Line Limit in Bus 3 to Bus 4	71
C.6	IEEE 30-Bus With 20% TCSC On Bus 3 to Bus 4	72
C.7	IEEE 30-Bus With 20% TCSC On Bus 1 to Bus 3	73
C.8	IEEE 30-Bus With 20% TCSC On Bus 2 to Bus 4	74
C.9	IEEE 30-Bus With 20% TCSC On Bus 3 to Bus 4	75
C.10	IEEE 30-Bus With 20% TCSC On Bus 2 to Bus 5	76
C.11	IEEE 30-Bus With 20% TCSC On Bus 2 to Bus 6	77
C.12	IEEE 30-Bus With 20% TCSC On Bus 4 to Bus 6	78
C.13	IEEE 30-Bus With 20% TCSC On Bus 5 to Bus 7	79

CHAPTER 1

INTRODUCTION

1.1 Introduction

Despite the rapid and extreme pace of world development in recent year, the rate of growth for transmission facilities construction speed is still much slower compared to load demand growth. Amongst the reason is because the power utility operator is still using the existing infrastructure with minimum investment to meet this load demand growth. In addition, environmental factor, economic reasons and other factors also contribute to this dilemma. After years of research and observation, Flexible AC Transmission System (FACTS) is introduced to solve this problem.

1.2 Problem Statement

From the introduction, there is a lot of FACTS technology that can be used to enhance system performance by controlling the power flows in the network. Each FACTs devices is suitable in different application such as load flow control, voltage control. Hence the optimal location of FACTS devices should be determined.

1.3 Objectives

The main objectives of this project is to determine the optimal location of TCSC devices in order to relieve the system congestion. The methodology will be carried out in a 5-bus system, IEEE 14-bus system and finally IEEE 30-bus system. Other sub-objective is to master the application to perform power flow and to simulate power flow analysis using software such as MATLAB and POWERWORLD.

1.4 Scope of Work

In order to achieve the research objective several works need to be done. First to perform literature review on previous researchers works, to study FACTS devices and explore which is suitable for steady state condition. Besides, the method to solve power flow in power system need to be explore and master in order to determine which is the most suitable method to carry out power flow calculation. Follow by deciding the method for determining the optimal location for TCSC. Lastly, the results of optimal location is verified by using software simulation.

1.5 Project Organization

This project is represented by five chapters as below:

Chapter 1: Introduction to this project is being discussed. The problem statement, objectives, scope of works and project outlines is elaborated.

Chapter 2: Discussion about the FACTS technology in power system, the types of the FACTS devices and how they are being installed and performed in power system. This chapter is to have a review on other researchers' works on deciding the optimal location of FACTS devices mainly on the sensitivity analysis approach.

Chapter 3: The methodology and software being used in this project is elaborated. Two main software to be used in this project is MATLAB and POWERWORLD.

Chapter 4: This chapter is the results and discussion obtained in this project which is tested differently on 5-bus test system, IEEE 14-Bus test system and IEEE 30-Bus test system.

Chapter 5: The last chapter is about the conclusion of this project and the future possible works which can be done to fine tune the optimal location of TCSC in power system.

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