

**CAPACITOR SWITCHING TRANSIENT ANALYSIS ON  
A TRANSMISSION GRID SUBSTATION  
(CASE STUDY: THULHIRIYA GSS)**

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Dissertation submitted in partial fulfillment of the requirement for the  
Degree of Master of Science

Department of Electrical Engineering

University of Moratuwa  
Sri Lanka

June 2015

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## ACKNOWLEDGEMENT

I sincerely thank my supervisor, Dr. K.T.M.U. Hemapala for his great supervision and guidance offered for the successful completion of this study. I extend my sincere thanks to lecturers of Electrical Engineering Department, University of Moratuwa, who gave me the theoretical knowledge and the support during the study period to make the study practical and meaningful.

My special thanks go to Dr. U.N. Gnanarathna, University of Manitoba, Canada, who spent his valuable time to guide me and providing valuable information required for this study.

I am also grateful to Centralized section and Kandy region of Transmission Operation and maintenance branch and my colleagues in Ceylon Electricity Board, who supported and encourages me in numerous ways to successful completion of this study.



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It is also with great pleasure that I remember the encouragement and support extended by the colleagues in the post graduate program and specially my parents and my wife. May be I could not have completed this research without their valuable support.

## ABSTRACT

The quality of electric power system has a great concern and also it has been a constant topic of study. A transient originated from capacitor bank switching are main reason which affects the power quality. The analysis, simulation and optimal use of capacitor banks under harmonic conditions are required in a power network to optimally locate and sizing of a capacitor bank. If the capacitor banks are not properly selected and placed in the power system they could amplify and propagate harmonics, deteriorate the power quality to unacceptable levels and the transients produce under different conditions will be negatively affected to the switchgears in the substation.

The breaker switched capacitor (BSC) banks are commonly used for power factor correction, reactive power requirement and voltage support by many utilities in the world. Ceylon electricity board (CEB) has also installed total of 370 Mvar capacitor banks island-wide in transmission grid substations (GSS) in 33 kV level.

The motivation for the study is the failure of 100 Mvar BSC banks installed at the Pannipitiya GSS after putting in to operations. After this incident the Thulhiriya GSS and Athurugitriya GSS BSC banks were switched off since they also came under same project with same equipment. In this study the Thulhiriya GSS was selected as the case study to analyze the switching transients of the 33 kV BSC banks to the system.

Data for the selected substation were recorded and analyzed and the selected substation was modeled using PSCAD simulation program to analyze the transients and harmonics. The objective of the study is to investigate the particular BSC bank is safe for operations without under utilizing by comparing the obtained simulated results with the standards and specifications, observe the switching transients and harmonics, introduce a safe region for closing of the BSC banks, introduce a proper sequence for closing of the BSC banks and introduce time delays for back to back switching of the BSC banks with minimum effect to the quality of the waveform.

The results obtained for the particular substation are expected to be extrapolated to a general concept to suit the whole substations in the CEB network.

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## LIST OF ABBREVIATIONS

AIS	Air Insulated Switchgear
BSC	Breaker Switched Capacitor
CEB	Ceylon Electricity Board
CBT	Circuit Breaker Tester
EMTP	Electro Magnetic Transient Program
FFT	Fast Fourier Transform
GIS	Gas Insulated Switchgear
GUI	Graphical User Interphase
GSS	Grid Substation
IEEE	Institute of Electrical and Electronic Engineers
IEC	International Electrotechnical Commission
PCB	Poly Chlorinated Biphenyl
PQA	Power Quality Analyzer
PSCAD	Power System Computer Aided Design
PLC	Programmable Logic Controller
RTU	Remote Terminal Unit
RMS	Root Mean Square
THD	Total Harmonic Distortion



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