

**DESIGN OF BATTERY SUPPLEMENTED MICRO-STATCOM
AND DEVELOPMENT OF ASSOCIATED CONTROL
ALGORITHMS TO MITIGATE POWER QUALITY ISSUES IN
LOW VOLTAGE NETWORKS**

Hennayaka Mudiyanse Lage Sisira Kumara Hennayaka

(168514A)

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Department of Electrical Engineering

University of Moratuwa

Sri Lanka

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DECLARATION

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Signature of the Author:
H. M. S. K. Hennayaka



Date: 2021.01.09

The above candidate has carried out research for the Masters Dissertation under my supervision.

Signature of the supervisor:



Dr. J. V. U. P. Jayatunga
Department of Electrical Engineering,
University of Moratuwa.

Date: 2021.01.10

ABSTRACT

Power Distribution Networks are evolving with the rapid penetration of distributed generators and introduction of concepts such as *micro grid based Smart Grids*. Distribution automation devices and solar PV generators in the present-day power systems makes power distribution networks more and more active. Assurance of a power supply with better power quality for a distribution customer is becoming a challenging task with the penetration of various loads inspired by power electronic concepts. And also, with the enormous penetration of solar PV generators to power distribution networks, bi-directional power flow makes it more challenging. As most of the planning studies carried out to improve Medium Voltage (MV) Networks to address these challenges, less attention has paid for the monitoring of power qualities at Low Voltage (LV) Distribution Networks.

This research identifies a vital requirement to improve power quality at the leaf level of LV distribution network and presents a combined solution for most predominant power quality issues exist in LV distribution network. This thesis presents a Micro-STATCOM based solution to address power quality issues by under voltage regulation, over voltage regulation, harmonic mitigation and improving system power factor in LV distribution system. Development of Micro-STATCOM based model with DC power source is presented in order to mitigate major power quality issues exists in the modern LV distribution systems. Performance of the Micro-STATCOM model has evaluated with response time for voltage regulation, resolution of voltage regulation and level of reduction in Total Harmonic Distortion (THD%).

Developed Micro-STATCOM was then integrated into modified IEEE 13 Distribution Bus System in order to observe the mitigation of power quality issues. Results obtained by mitigation of each power quality issues in the distribution network are discussed in this thesis. Potential applicability of developed Micro-STATCOM in the practical low voltage distribution networks and other areas are discussed and recommendations are made for the selection criteria to integrate Micro-STATCOMs in LV distribution Systems.

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LIST OF ABBREVIATIONS

BESS	:	Battery Energy Storage System
DG	:	Distributed Generators
PV	:	Photovoltaic
SCADA	:	Supervisory Control and Data Acquisition
GPS	:	Geographical Positioning Systems
PMU	:	Phasor Measurement Unit
WAMS	:	Wide Area Measurement System
DAS	:	Distribution Automation System
DRMS	:	Demand Response Management Systems
LV	:	Low Voltage
MV	:	Medium Voltage
THD	:	Total Harmonic Distortion
PCC	:	Point of Common Coupling
STATCOM	:	Static Synchronous Compensator
SPWM	:	Sinusoidal Pulse Width Modulator
CEB	:	Ceylon Electricity Board
AC	:	Alternating Current
DC	:	Direct Current
RMS	:	Root Mean Square
PQ	:	Power Quality
FACTS	:	Flexible AC transmission system
OLTC	:	On Load Tap Changer
TCSR	:	Thyristor Controlled Series Reactor
SVC	:	Static VAR Compensator
VOC	:	Voltage Oriented Control
MPPT	:	Maximum Power Point Tracking
IGBT	:	Insulated Gate Bipolar Transistor
IEEE	:	Institute of Electrical and Electronics Engineers
FFT	:	Fast Fourier Transform