**ABSTRACT**

The power electronic based loads offer highly nonlinear characteristics. Due to their non linearity, the loads are simultaneously the major causes and the major victims of power quality problems. Harmonics voltage sag/swell and persistent quasi steady state harmonics, dynamic switching excursions can result in electric equipment failure, malfunction, hot neutral, fire and shock hazard in addition to poor power factor and inefficient utilization of electric energy. To improve the efficiency, capacitors are employed which also lead to the improvement of power factor of the mains.

This project presents a novel modulated power filter compensator (MPFC) scheme for the efficient utilization. The modulated power filter compensator is controlled by the on-off timing sequence of the pulse width modulation (PMW) switching pulses that are generated by a novel tri-loop dynamic error driven inter coupled modified PID controller.

The Matlab digital simulation models of the proposed MPFC scheme has been fully validated for effective power quality (PQ) improvement for voltage stabilization, power factor correction and transmission line loss reduction. The proposed FACTS based scheme is easily modified for other specific stabilization, compensation requirements, voltage regulation and efficient utilization.

**TABLE OF CONTENTS**

**Chapter Page No**

**I Introduction [01-03]**

1.1 Overview 01

**II** **Literature Survey** **[4-5]**

**III**   **Problem Formulation**  **6**

**IV**  **Objective of the Thesis** **[7-8]**

4.1 Organization of the Thesis 07

**V Power Quality [09-13]**

5.1 Introduction 09

5.2 Power Quality Problems 10

5.3 The Benefits of Power Quality 12

5.4 Summary 13

**VI Active Power Filters [14-23]**

6.1 Introduction 14

6.2 Classification of Active Filters 14

6.3 Shunt Active Filters 16

6.4 Series Active Filters 17

6.5 Other Combinations 18

6.6 Harmonic Compensation 21

6.7 Balancing of Three Phase Systems 22

6.8 Multiple Compensation 22

6.9 Summary 23

**VII Flexible AC Transmission Systems (FACTS) [24-32]**

7.1 Introduction 24

7.2 Configurations of FACTS Devices 25

7.3 Summary 32

**VIII Voltage Source Inverter [33-36]**

8.1 Introduction 33

8.2 Pulse Width Modulation 33

8.3 Pulse Width Modulator 34 8.4 Summary 36

**IX Modeling Of Case Study [37-39]**

9.1 Introduction 37

9.2 Tri Loop Error Driven Modified PID Controller 38

9.3 Summary 39

**X MATLAB Design Of Case Study And Results [40-52]**

10.1 Introduction 40

10.2 Block diagram of normal loading operation without MPFC 40

and with MPFC

10.3 Simulation results of normal loading operation case 41

without MPFC and with MPFC

10.4 Block diagram of short circuit fault condition 46

case without MPFC and with MPFC

10.5 Simulation results of short circuit fault condition 47

case without MPFC and with MPFC

10.6 Block diagram of hybrid local load excursion 48

case without MPFC and with MPFC

10.7 Simulation results of hybrid load excursion 49

case without MPFC and with MPFC

10.8 Results 52

**XI**  **Conclusion And Scope For Future Work**  **[53]**

**References [54-55]**

**Appendices 68**

**LIST OF FIGURES**

**Fig No**: **Pg. No**:

6.1 Generalized block diagram of active filter 14

6.2 Sub division of active filter according to speed response and 15

power rating

6.3 Shunt active filter alone 17

6.4 Shunt active filter network configuration 17

6.5 Series active filter configuration 18

6.6 Series active filter alone 18

6.7 Combination of shunt and series filter 19

6.8 Combination of shunt active and passive filters 20

6.9 Active filter in series with the passive filter 21

7.1 Operational limits of transmission lines 25

for different voltage levels

7.2 SVC building blocks and voltage / current characteristic 27

7.3 STATCOM structure and voltage / current characteristic 28

7.4 Thyristor Controlled Series Capacitors 30

8.1 Pulse width modulation 34

8.2 Output of a Comparator 34

8.3 Duty Cycle 36

9.1 Modified Power Filter Compensator structure 37

9.2 Modified tri loop error driven PID controller 38

9.3 MATLAB functional model of the Inter-coupled tri loop error driven 39

modified PID controller

9.4 The single line diagram of the unified EHV study AC system 39

10.1 Block Diagram of Normal Loading Operation Case without MPFC 40

10.2 Block Diagram of Normal Loading Operation Case with MPFC 41

10.3 The RMS voltage at Generator bus without MPFC 41

10.4 The RMS voltage at Generator bus with MPFC 41

10.5 The RMS voltage at Load bus without MPFC 42

10.6 The RMS voltage at Load bus with MPFC 42

10.7 The power factor at Generator bus without MPFC 42

10.8 The power factor at Generator bus with MPFC 43

10.9 The power factor at Load bus without MPFC 43

10.10 The power factor at Load bus with MPFC 43

10.11 The RMS voltage at the infinite bus without MPFC 44

10.12 The RMS voltage at the infinite bus with MPFC 44

10.13 The power factor at the infinite bus without MPFC 44

10.14 The power factor at the infinite bus with MPFC 45

10.15 The voltage waveforms of MPFC 45 10.16 Sa and Sb pulsing signals 46

10.17 Block Diagram of Short Circuit Fault Condition Case without MPFC 46

10.18 Block Diagram of Short Circuit Fault Condition Case with MPFC 47

10.19 The RMS voltage at generator bus without MPFC 47

10.20 The RMS voltage at generator bus with MPFC 47

10.21 The RMS voltage at Load bus without MPFC 48

10.22 The RMS voltage at Load bus with MPFC 48

10.23 Block Diagram of Hybrid Local Load Excursion Case without MPFC 49

10.24 Block Diagram of Hybrid Local Load Excursions Case with MPFC 49

10.25 The RMS voltage waveform at the generator bus without MPFC 50

10.26 The RMS voltage waveform at the generator bus with MPFC 50

10.27 The RMS voltage waveform at the load bus without MPFC 50

10.28 The RMS voltage waveform at the load bus with MPFC 51

10.29 THD of Voltage waveforms at load bus without MPFC 51

10.30 THD of Voltage waveforms at load bus with MPFC 52

10.31 THD of Voltage waveform at infinite bus without MPFC 52

**ABBREVIATIONS**

* DC Direct current
* AC Alternating current
* SCR Silicon controlled rectifiers
* KVA Kilo volt ampere
* PWM Pulse Width Modulation
* PCC Point of common coupling
* VAR Volt ampere rating
* FACTS Flexible AC transmission systems
* THD Total harmonic distortion
* RMS Root mean square
* IGBT Insulated Gate Bipolar Transistor
* IGCT Insulated Gate Commutated Thyristor
* SVC Static Var Compensator
* STATCOM ­­­­­­­­­­­­­ Static Compensator
* HVDC High voltage direct current
* GTO Gate-Turn-off Thyristor
* TCSC Thyristor Controlled Series Capacitors
* SSR Sub Synchronous Resonance
* VSI Voltage source inverters
* MPFC Modified Power Filter Compensator
* PID Proportional integral differential controller

**NOMENCLATURE**

* V dc -DC output voltage
* V av -The average DC output voltage
* V p -The peak value of half wave
* V rms -The root mean square value of output voltage
* V a  -ac output voltage
* VD -carrier signal
* Vg -Rated voltage
* Xl -Leakage reactance
* Xd -Direct axis synchronous reactance
* Xq - Quadrature axis synchronous reactance
* Xd’ - Direct axis transient reactance
* Xd­­­’’- Direct axis sub transient reactance
* Xq’ - Quadrature axis transient reactance
* Xq’’ - Quadrature axis sub transient reactance
* Rs -Stator resistance
* Ls -Stator leakage indutance