AIN SHAMS UNIVERSTY
FACULTY OF ENGINEERING
ELECTRICAL POWER & MACHINE DEPARTMENT

ACTIVE FILTERS APPLICATION FOR METRO AC SUBSTATIONS

The thesis submitted in Partial Fulfillment of Doctor of Philosophy degree in Electrical power engineering

By

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APPROVAL SHEET

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Presented by
Eng. Ashraf Magid Rezkalla

This thesis is submitted by in Partial Fulfillment of Doctor Philosophy degree in Electrical power engineering (power and Machines).
The examining committee approve that the thesis meets the standard of the Ph.D. degree in electric power engineering

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STATEMENT

This thesis is submitted to Ain Shams university in partial fulfillment of the requirement for the degree of Doctor Philosophy in Electrical power engineering (power and Machines).

The work included in this thesis is carried out by the author at the electrical power and Machines department , Ain Shams University. No part of this thesis has been submitted for a degree or a qualification at any other university or institute.

Ashraf Magid Rezkalla
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Abstract

Non linear loads, such as switch mode power supplies, and adjustable speed drives in three phase three wires power distribution systems can cause line current and voltage system distortions.
The non linear loads on three phases three wires power distribution system are produced dominantly by 5^{th} and 7^{th} order harmonic currents. Increasing of harmonics current on electric power distribution system leads to degradation of system performance. To reduce the harmonic currents on power distribution system the 5^{th} and 7^{th} order harmonic currents components should be minimized.

In Cairo METRO network system, diode rectifiers are commonly used in the front end of a power converter as an interface with the electric dc Metro network supply system. Rectifiers are nonlinear in nature and, consequently, generate harmonic currents into the ac power source. The nonlinear operation of the diode rectifiers causes highly distorted input current on the ac side of the system. The non-sinusoidal shape of the input current drawn by the rectifiers causes a number of problems in the sensitive electronic equipment and in the power distribution network. The distorted input current flowing through the system produces distorted voltages at the point of common coupling (PCC).

The recommended practice, IEEE- 519, and IEC 1000-3 has evolved to maintain utility power quality at acceptable levels. In order to meet requirements, a cost-effective and economical solution to mitigate harmonics generated by power electronic

equipment is currently of high interest. One approach is to use 12-pulse converter configuration; using a phase shift power transformer to achieve low harmonics content at the ac line current and low ripple at the dc output voltage. This method is currently used in Metro system rectifier station to improve system power quality. This method, however, includes bulky transformer equipment, and does not completely eliminate the required harmonics.

The proposed solution for system power quality improvement in this research is to use the usual conventional rectifier stations with active harmonic filter by using micro controller model technique. This system reduces the THD in the ac source current from 9% to 3% and also reduces the ripples in the dc output voltage; with the advantage of simple, lower source voltage THD, size, and cost.

LIST OF CONTENTS

LIST OF FIGURES

CHAPTER 1

CHAPTER 2