AUTOMATIC POWER FACTOR CORRECTION

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"I hereby declare that I have read this project report and in my opinion this project report is sufficient in terms of scope and quality for awarding the degree of Bachelor of Electrical Engineering (Industrial Power)"

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Date: 8 May 2009 ……

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A project report submitted in partial fulfilment of the requirements for awarding the degree of Bachelor of Electrical Engineering (Power Industry)"

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MAY 2009

I declare that this project report entitled "*Automatic Power Factor Correction*" is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature: ……..……..

Name: Roslina Binti Mohd Razak

Date: 8 May 2009

To my beloved family and friends...

Thank You

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Alhamdulillah. I am greatly indebted to Allah on His mercy and blessing for making this project successful.

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ABSTRACT

This paper discusses the design, implementation and analysis of a single phase (240V, 50Hz) capacitor bank controller unit. Power factor correction using capacitor banks reduces reactive power consumption which will lead to minimization of losses and at the same time increases the electrical system's efficiency. Power saving issues and reactive power management has brought to the creation of single phase capacitor banks for domestic applications. The development of this project is to enhance and upgrade the operation of single phase capacitor banks by developing a micro-processor based control system. The control unit will be able to control capacitor bank operating steps based on the varying load current. Current transformer is used to measure the load current for sampling purposes. This project applies the Peripheral Interface Controller (PIC) microcontroller to produce switching commands in order to control the capacitor bank steps. Intelligent control using this micro-processor control unit ensures even utilization of capacitor steps, minimizes number of switching operations and optimizes power factor correction. Fluorescent lamp will be use as loads in this single phase capacitor bank developments. That fluorescent lamp shall be divided into different load value to enable capacitor bank model is controlled systematically.

ABSTRAK

Tesis ini membincangkan rekabentuk, pembangunan serta analisa keberkesanan unit pengawal bank kapasitor satu fasa (240V,50Hz). Pembetulan faktor kuasa menggunakan bank kapasitor berupaya mengurangkan penggunaan kuasa reaktif yang secara tidak langsung mengurangkan kehilangan kuasa dan dalam pada masa yang sama meningkatkan kecekapan sistem elektrik satu fasa. Dalam usaha menjimatkan tenaga, kini kapasitor bank bagi litar satu fasa untuk kegunaan domestik dihasilkan. Pembangunan projek ini antara lain bertujuan meningkatkan serta memperbaiki pengoperasian bank kapasitor satu fasa yang sedia ada dengan menggunakan miropengawal. Unit pengawal yang akan dihasilkan ini berupaya mengawal turutan operasi bank kapasitor bergantung kepada arus yang berubah mengikut beban. Transformer arus digunakan bagi menghasilkan arahan pensuisan untuk menambah atau mengurangkan turutan kapasitor. Projek ini akan mengaplikasikan penggunaan mikropengawal PIC (*Peripheral Interface Controller*) yang akan memproses data dan mengawal pengoperasian bank kapasitor. Kawalan pintar menggunakan unit pengawal membolehkan turutan bank kapasitor dikawal secara teratur, meminimakan operasi pensuisan serta mengoptimumkan pembetulan faktor kuasa. Lampu kalimantang akan digunakan sebagai beban dalam pembangunan pengawal bank kapasitor satu fasa ini. Lampu tersebut akan dibahagikan kepada beban yang berlainan nilai bagi membolehkan turutan bank kapasitor dikawal secara teratur.

TABLE OF CONTENTS

LIST OF TABLE

NO TITLE PAGE

LIST OF FIGURE

LIST OF SYMBOL

A	-	Ampere
V	-	Voltan
P	-	Real Power
Q	-	Reactive Power
S	-	Apparent Power
PCB	-	Printed Circuit Board
PIC	-	Peripheral Interface Controller
IEEE	-	Institution of Electrical and Electronics Engineering
IC	-	Integrated Circuit
SPI	-	Serial Peripheral Interface
TNB	-	Tenaga Nasional Berhad
R	-	Resistor or resistance
L	-	Inductor
C	-	Capacitor
X	-	Reactance
Z	-	Impedance
kW	-	kilo-Watt
kVA	-	kilo-Volt-Ampere
kVAR	-	kilo-volt-Ampere-Reactive
P.F	-	Power Factor
I	-	Current

APPENDIX

CHAPTER 1

INTRODUCTION

1.1 Project Background

Electrical energy efficiency is of prime importance to industrial and commercial companies operating in today's competitive markets. Optimum use of plant and equipment is one of the main concerns that industry tries to balance with energy efficiency, for both economical and environmental reasons. As society becomes increasingly conscious of its impact on the environment, reduced energy consumption becomes more desirable, which, is an achievable goal for everyone. Through the use of measures such as power factor correction, electricity consumption is optimized, which ultimately leads to reduced energy consumption and reduced CO2 greenhouse gas emissions.

Within a cost conscious market, payback considerations are also important. This report identifies the most appropriate application for power factor correction based on energy consumption, tariff metering, cost payback and emission reduction. Power factor correction is an appropriate means by which to improve the power quality of an installation. Its application is dependent though on the size of the installation and the extent that power factor correction needs to be applied. The opportunity however exists to make a significant environmental contribution whilst simultaneously providing economic benefit.

Currently, the effective of the capacitor bank as power factor correction device was produced a capacitor bank to domestic use. Also known as energy stability, it will correct power factor base capacitor concept as compensator reactive current in the single phase electric circuit. However, this device is less efficiency because the static operation and did not control load change.

The project titled “Automatic Power Factor Correction” was developed to enable operation single phase capacitor bank to control follow load change. The operation of present single phase capacitor bank was not able to operate base of current change according the increase or reduction load. Because the present system could not detect load rating that changed, the operation inefficient and power factor correction not be optimum. This project is using fluorescent magnetic ballast as the load.

1.2 Problem Statement

This project developed to improve the weakness of static capacitor bank. Static capacitor bank is a traditional method was used to improve the power factor by using capacitor bank. In the configuration of static capacitor bank, the value of capacitor was fixed and cannot to control. The weakness of the static capacitor bank, which the operations:

i. Capacitive compensation does not change according to increase or reduction in loads.
ii. Could not detect load rating that change inefficiency
iii. Operation and power factor correction not optimized.

1.3 Target and Objectives of the Project

There are four objectives of this project, which is stated in the following texts:

i. To learn the way of power factor correction in power systems.
ii. To learn and identify methods to control capacitor banks.
iii. Identify one method of power factor correction with the low cost and practical.
iv. To provide an automatically controlled PFC unit that will bring the power factor to as near to unity as practical (typically 0.9) and have sufficient capacity for future PFC requirements or expansion.

1.4 Scope of the Project

In order to achieve this project objective, the following scopes will be covered:

1) Operation single phase capacitor bank (240V, 50Hz).
2) This project also will apply microcontroller Peripheral Interface Controller (PIC) 16F877 by using programming language C.
3) This project was developed to apply technique control base current by using current transformer which current adjust according to load change. This project will develop consecutive capacitor bank control by changing current.

1.5 Project Report Outline

Generally this project report is divided into six chapters, where it consists:

Chapter 1: Introduction
Chapter 2: Literature Review
Chapter 3: Project Methodology
Chapter 4: Basic Concept of Power System
Chapter 5: Development and Analysis
Chapter 6: Results and Discussions
Chapter 7: Conclusion and Recommendation

Chapter 1 is an overview of the research project in whole, the problem statement, objective and scope of research project are defined. The research project that will be done are based on the objectives and scopes that been stated earlier.

Chapter 2 presents the literature review of the automatic power factor correction project. Studies on literature review helps in understanding the fundamental of the project. Main hardware component, software and calculation will be discussed in this chapter.

Chapter 3 will discuss about the methodology that shall adopted for this project work which basically defined the planning process flow and principles that is essential guide to

produce a well planning project. Besides, selected approach or methodology will describe the activities that might be done in every stage.

Chapter 4 in this chapter the theoretical and concept of power system will be explained. It was to provide the basic concept of power system constructs.

Chapter 5 covers the major parts of the hardware and software implementation. The hardware development and circuit design will be discussed in detail in this chapter. Concept and operation circuit combination power supply, current input circuit and control circuit discussed with more advanced in this chapter.

Chapter 6 will be discussed the project testing and result. Where the collected data from experimental work will be gathered before the analysis will be performed. The 5 final sections from this chapter are the discussion for the gathered data will be explained.

Chapter 7 will conclude all the works and had been presented in previous chapter and all the results of the project. This is followed by recommendations for the future study work.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter, literature review that related to this study case will be identify and study. Generally, these papers are related with the topic power factor correction by using capacitor bank. Power factor correction is an appropriate means by which to improve the power quality of an installation. These papers researches about capacitor bank that a purpose to get scientific information, analysis and study the weakness concept and method how to improve the present power factor through the developing project.

2.2 Literature review

[1]In this thesis, a hardware configuration and software specification for two prototypes that was developed and able to control voltage, reactive power control (Q) and protection system of capacitor bank would be identify and study. The first prototype is to monitor bus voltage, power flow and power factor to specify whether capacitor bank will operate or not. Second prototype is monitoring impedance obvious phase and null sequence capacitor bank current to detect flamed fuse in capacitor fund. Both software combination prototypes will produce one system that can control and protect capacitor bank from over voltage that will cause the fuse capacitor flamed.

[2]It is also to explain a control capacitor bank which used traditional microcontroller by using relay. Majority relay use currently was combined protection system function and traditional logic function in one device. This concept was applied in this paper to develop a basic control scheme for a capacitor bank with five consecutive models which use one microcontroller with relay. An application special relay is a control consecutive capacitor bank which can be activated required consecutive to accommodate

voltage. A controller's instrument is required to monitor bus voltage and will activate consecutive capacitor bank follow voltage will. This paper develop basic concept of control to control capacitor bank on staggered method.

[3]Therefore, this thesis also to explain the effect of installation capacitor bank for improvement power factor. This paper explains a power system theoretical basis and important parameters in power system as active power (P), apparent power (S) and reactive power (Q). Power triangle and power factor also be discussed. This paper also discusses when low power factor, consumer having to pay too much. Low power factor too is indicator that system is not efficient and will be electricity loss. Advantage or good correction power factor also be discussed. Through the process power factor improvement, demand for apparent power (S) and reactive power (Q) could be reduced to both generator and consumers. Lost electricity also could be reduced and system voltage can be increased. Power factor corrections methods discuss include method synchronous motor, static capacitor bank and automatic capacitor bank. Capacitor bank, either static or automatic use by widespread base low material cost and easy maintenance. This paper also discusses case-study carried out to study effect location of capacitor bank, size, and voltage increase.

2.3 Conclusion

Installation capacitor bank for power factor correction will obtain profitable both sides consumer and electric flow. Thesis also shows capacitor bank was used extensively by the high-power user as industry sector and commercial. Installation of capacitor bank can reduce reactive current consumption further minimize a losses. There were various types of connection and protection to optimize efficiency and life span of capacitor bank. Apart from that, capacitor bank operation for power factor correction will control with variety of techniques. However, this paper more focuses to the three phase system capacitor bank.
Based on literature review those carried out, single phase power factor correction by using capacitor bank was still new and not as much of discuss. Project Automatic Power Factor Correction this was developed based on idea and basic concept of three phase automatic capacitor bank. Idea and basic of control concept automatic capacitor bank are using microcontroller and switching operation use relay was applied in this project development.

However, capacitor bank controller was applying traditional microcontroller while this project will apply modern microcontroller which easier and efficient.