"I hereby declare that this report is qualified in form of scope and quality to earn a graduation in Bachelor of Electrical Engineering (Mechatronic)"

Signature :……

Supervisor Name :MR. ALIAS BIN KHAMIS

Date :22TH APRIL 2009

HIGH FREQUENCY ELECTRONIC BALLAST PROTECTION

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This Report is Submitted in Partial Fulfillment of Requirements For The Degree of Bachelor in Electrical Engineering (Mechatronic)

Faculty of Electrical Engineering
Universiti Teknikal Malaysia Melaka

APRIL 2009

"I hereby declared that this report is a result of my own work except for the excerpts that have been cited clearly in the references"

Signature :……..

Student's Name : CATHERINE MUNA AK GEORGE MALANG

Date : 22TH APRIL 2009

"I hereby declared that I have read through this report and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Mechatronic)"

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ABSTRACT

High frequency electronic ballast is the best choice to save energy absorbed by the lighting. However, the protection for electronic ballast is most important to avoid it from fault and light. The FAN7710 has developed using Fairchild's unique high voltage process and system-in-package concept, is a ballast control integrated circuit (IC) for a compact fluorescent lamp (CFL). The FAN7710's high functionality and built-in protection, features save board spaces, reduce power dissipation, and result in excellent temperature characteristic and enhance reliability in end system. It will include the combination of two 550V MOSFETs, high-side gate driver circuit, frequency control circuit and shunt regulator, active ZVS control, and open lamp detection. The design is able to drive 20W compact fluorescent lamp for the light $310V_{DC}$ voltage.

ABSTRAK

Lampu elektonik ballast adalah pilihan terbaik untuk menjimatkan sistem tenaga dan system pencahayaan. Walaubagaimanapun, Perlindungan untul lampu elektronik ballast sangat penting untuk mengelak daripada kerosakan dan kilat. FAN7710 telah diperkenalkan dengan proses voltan tinggi *Fairchild's* dan konsep *system-in-package*, merupakan IC kawalan ballast untuk lampu pendaflour. FAN7710 dengan pelbagai fungsi dan perlindungan di dalam, mengurangkan pengunaan ruang litar, mengurangkan kehilangan kuasa bekalan, dan keputusan adalah dalam sifat suhu dan meninggikan kesesuaian pada penghujung sistem. Ia mengandungi dua MOSFET 550V, litar *high-side gate driver*, litar kawakan frekuensi dan pengatur pengubah, *active ZVS control*, dan pengesan lampu trbuka. Rekaan ini adalah sesuai untuk lampu pendaflour 20W untuk voltan $310V_{DC.}$

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LIST OF ABBREVIATION

DC	– Direct Current
CFL	– Compact Fluorescent Lamp
MOSFET	– Metal-Oxide-Semiconductor Field-Effect Transistor
IC	– Integrated Circuit
ZVS	– Zero Voltage Switching
PCB	– Printed Circuit Board

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CHAPTER 1

INTRODUCTION

1.0 Background

An electromagnetic radiation of a wavelength that is visible to the human eye is a defined for light or visible light. However, whether visible or nit, the light is often used to refer to electromagnetic radiation of all wavelength in the broader field of physics. The development of modern lamps is overcome after the discovery of electrical power and possibility of transmitted. Today, lamps is the electrical component which a very important in our life. Many of types of lamp are being manufactured as incandescent lamp, fluorescent lamp, and discharge lamp.

However, one of the lamps are more popular was introduced commercially in the 1940s called fluorescent lamp. It continued to be used in the 21st century and has since evolved into many variations of outlook, applications and control. But, the fluorescent lamp uses a ballast to provide a starting kick and to limit the current to its operating value for the tube. There are basically 2 types of ballasts namely magnetic ballast and electronic ballast design. The magnetic ballast uses a core and coil assembly transformer that provides a minumum function of starting and operating the lamp. Hence it is not as efficient as the electronic ballast. Electronic ballast operates at high frequencies from 20kHz to 45kHz and uses electronics circuitry to optimize the operation of the lamp.

Electronic ballast is most popular two years ago because it more cheaper compare with magnetic ballast. But today, a request for electronic ballast from customer is reduced because it easy to damage from fault and light. By implementing the protection for the electronic ballast, it can be save energy and increase a lamp lift-time.

1.1 Project objectives

The main objectives of this project are

1. Develop a high frequency electronic ballast protection for avoided from fault and light.
2. Develop an internal controller which is detects open-lamp condition without the expense of external circuitry.
3. Comparison between electronic ballast and electronic ballast with protection.
4. Enhance knowledge and an experience in project management and to carry out the project

1.2 Project scopes

Figure 1.1: Scope of construction electronic ballast with protection

The scope of this project is consists of software, rectifier, FAN7710, and resonant filter. A software has used for simulation are OrCad and Multism. A full bridge rectifier uses four diodes in a bridge arrangement to achieve a full-wave rectification. It also uses to convert AC power to DC power. The FAN 7710 is a ballast control integrated circuit (IC) which is controls internal high-voltage stress. Then, the resonant filter will be uses to eliminate the undesired harmonic components. Lastly, a comparison between electronic ballast and electronic ballast with protection will be done by circuit analysis. The inverter component is not includes in scope of project because the half bridge inverter is already inside of FAN7710.

1.3 Problem statements

The high frequency electronic ballast is an electronic control device that can save energy of the lighting system. However, the problem for electronic ballast is a short life-time because there is no any protection from fault and light. Now, the design of high frequency electronic ballast with protection must be perform four functions:

1. The circuit must be adversely affect other electrical devices with high frequency devices introduce harmonic distortion in the power circuit.
2. Construct a high-side driver built included an inverter inside.
3. Incorporates a preheating and ignition function to increase lamp life.
4. Assure that the circuit will remain stable and prevents stress on MOSFETs.

1.4 Thesis outline

For the high frequency electronic ballast protection projects, the report will begin with design a one circuit for electronic ballast with a protection to delivers a 36W compact fluorescent lamp. It consists on five sections in detail. The section of this report is includes the introduction, literature review, methodology, results and discussions, and conclusion.

Firstly, in chapter one is consist of introduction for the project which is discussed about the characteristic of the lamp. For every type of lamp are different criteria. Beside that, the project objective, scope, problem statement and thesis outline for this chapter is included.

Then, the chapter two is about the literature review that is for a make a comparison between electronic ballast and electronic ballast protection. The comparison is discuss about the operational and the problem caused by electronic ballast. Electronic ballast with protection alternative is overcome to encounter the problems. The detail each part of electronic ballast with protection will be discussed in this chapter.

In chapter three, it will be include the methodology part. In this part, the technique and consideration that applied during carried out PSM1 is discussed. A simulation has done to get an expected result by simulate the design circuit before proceed to the hardware part.

For PSM1, the discussion and result is base on simulation and expected result. The simulation is done to the design circuit to ensure it can be functionally probably. The hardware part is not including in PSM1 because it will be proceed on PSM2. Lastly, the analysis is done according to the results.

1.5 Project planning

Table 1.1: Gantt chart for project planning

	Project Activities	J	J	A	S	O	N	D	J	F	M	A	M
1	Choosing title for Final Year Project	x	x										
2	Research on electronic ballast and protection	x	x	x	x								
3	Submitted the proposal			x									
4	Study and design circuit				x	x	x	x	x	x			
5	Simulation					x	x	x					
6	Presentation PSM1				x	x							
7	List of components and identify function of components					x	x						
8	Build and troubleshoot the hardware						x	x	x	x			
9	Analysis circuit (Comparison between electronic ballast and electronic ballast with protection)									x	x	x	
10	Written thesis and presentation PSM2										x	x	x

CHAPTER 2

LITERATURE REVIEW

2.1 Electronic ballast

Electronic ballast design is becoming more common due to its superior performance. It outputs 10%-15% more light output, does not have the 50/60 cycles irritating hum, high frequency switching that does not have visible flicker to the human eyes, cooler and more reliable. Operating the ballast at higher frequency means that the design can be smaller and made compact. It utilizes the switching mode power supply technology electronic ballasts can be categorized into 3 categories as an instant start, rapid start and programmed start.

Instant start ballasts require an instant-start certified lamp and ignite a lamp in about 80 milliseconds or less using a high frequency electronic circuit. It starts the lamp without heating the cathodes by using a high voltage at around 600V. It is the most efficient energy type when used in installations where the lamps are not turned on and off regularly.

Rapid start ballasts precisely heat the cathodes and then ignite the lamp with a lower charge. In this way, it helps to prolong the life of the lamp but it uses more energy as the cathodes are heated up continuously during the operation of the lamp. Programmed Start is an upgrade version of rapid start. It allows the cathodes to be preheated before applying the voltage to the lamps to strike an arc. This type gives the

best life to the lamps and is used in applications where frequent ON/OFF of lights is required.

Self-oscillating electronic ballasts has been proposed as a potential energy saving proposition for several environments and makes the electronic ballasts versatile without increasing significant cost. Beside that, it's used to ensuring a characteristic avoiding complexity, maintaining its well-known reliability and simplicity. The electronic ballast is reduced in size and components numbers comparing traditional automatic systems. The energy saving system will be implemented by self-oscillating gate-driver in electronic ballast application.

The high frequency electronic ballast is consists of rectifier, inverter, self-oscillating gate drive, and resonant filter. A bridge rectifier converts AC power to DC power. An inverter is used to converts DC power to AC power. A self-oscillating gate driver is used to switch on and off complimentary of transistors to produce a high frequency square wave of inverter output. The square wave is passed though the low-pass filter to eliminate the undesired harmonic components.

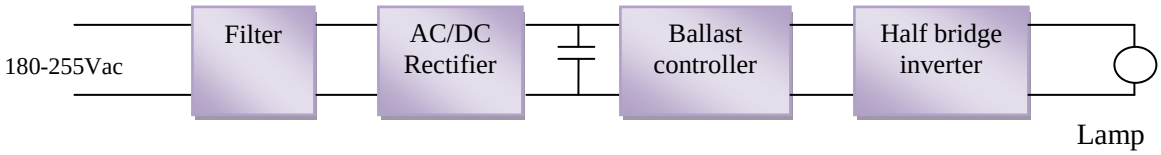

Figure 2.1: Electronic ballast block diagram

For the bridge rectifier, it will contain four diodes and one bulk capacitor. The AC mains voltage is rectified by four bridges rectifying diodes and the DC supply voltage for the half bridge inverter is smoothed by a buffer capacitor. The DC/AC inverter is a half-bridge series-resonant parallel-loaded converter. A filter is used to minimize the disturbance towards the mains. To generated a high frequency square waveform, two of MOSFETs is used as a switches, and switch on and off position complementarily with a fixed dead time.