"I / We admit that I / We have read this literature work through my/our observation which has fulfilled the scope and quality in order to be qualified for the conferment of Bachelor Degree in Electronic Engineering (Industrial Electronics)."

Signature : .....

Supervisor's name: MRS SITI HUZAIMAH BTE HUSIN

Date : MAY 2006

Self Oscillating Dimmable Electronic Ballast

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"I admit that this is done by my self except the discussion and extracts taken from other sources that I explained each in detail."

Signature : .....

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Date : 15 MAY 2006

DEDICATION

For my beloved parents for your advice and teach;
friends and colleagues for the helps and attentions;
lecturers in Fakulti kejuruteraan Elektronik & Kejuruteraan Komputer KUTKM
for the all of the knowledge given.

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ABSTRACT

The lighting system provides many opportunities for **cost-effective energy saving** without any sacrifice. The system is now part of the Energy Conservation program over the world and reduction of energy consumption by implementing energy conservation schemes is needed. Incandescent lamps convert just five per cent of energy into light and the remainder into heat where as fluorescent lamps turn 25 per cent of energy into light.

As the rapid development of power electronics technology, inverters are now used for energizing the lamp. These inverter systems are now referred as the electronic ballast and can eliminate the conventional magnetic ballast's disadvantages. A simple explanation for the system is the main input is rectified to a DC voltage which is then inverted into a high frequency AC voltage to drive the fluorescent lamp. Electronic ballasts can also be provided with a dimming capability. Dimming controls have been broadly employed in recent lighting systems to provide energy savings and improved economic.

The self oscillating dimmable electronic ballast that will construct in this project is hope will be useful not only in **energy saving** but also **low cost** and **high reliability.**

ABSTRAK

Sistem pencahayaan memberi banyak peluang bagi penjimatan tenaga secara kos efektif tanpa sebarang pengorbanan. Sistem ini sekarang merupakan sebahagian daripada program pemeliharaan tenaga (Energy Conservation) di seluruh dunia dan pengurangan penggunaan tenaga dengan melaksanakan skim pengekalan yang diperlukan.

Dengan pembangunan yang pesat di dalam teknologi elektronik kuasa, pengubah (inverter) dapat digunakan untuk penyalaan lampu. Sistem pengubah ini di kenali sebagai ballast elektronik dan ia boleh menghilangkan kelemahan ballast magnetic yang masih di guna pakai sekarang. Penerangan yang ringkas menegnai system ini ialah masukan utama di tukar kepada voltan arus terus yang mana kemudiannya di ubah kepada voltan arus ulang alik yang berfrekuensi tinggi untuk memacu lampu fluorescent. Ballast elektronik juga dapat disertakan dengan fungsi pemalap kawalan malapan telah banyak digunakan di dalam system pencahayaan yang ada sekarang bertujuan untuk menjimatkan tenaga dan meningkatkan ekonomi.

Litar yang akan dibina didalm projek ini di harap agar dapat digunakan bukan sahaja bagi menjimatkan tenaga tetapi juga murah dan berkeupayaan tinggi.

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CHAPTER I

INTRODUCTION

Ballasts are electrical devices that convert line current into the proper voltage, amperage, and waveform to operate fluorescent lamps. Over the past 10 years, ballast have been develops toward more efficient equipment. Electronic ballasts are the best choice in most applications today, either as replacements for magnetic ballasts in existing fixtures or in new installations.

To drive a fluorescent lamp, the electronic ballast, with respect to the magnetic ballast, presents the following features: reduced ballast loss (higher efficiency) and weight, facility on lamp power control, more efficient tube ignition, no flickering and operating conditions improving lamp life.

This project involves voltage fed series half bridge converters. This topology is operating in Zero Voltage Switching (ZVS) resonant mode which is reducing the switching losses. The project are based on L6569 device that are able to directly control a symmetric half bridge inverter of a fluorescent lamp ballast.

1.1 Project Objective

The objective of this final project is to gain knowledge in developing electronic ballast. By study the prospect and ability of electronic ballast, a simple and low cost electronic ballast circuit will be constructed. The circuit will be able to operate in selected frequency range for an 18 watt lamp and possibility for dimming are been study.

1.2 Project Scope

The scope for this project is to studies the electronic ballast function and then planning for the required specification of the electronic ballast. By using software, a development of the circuit by simulation is used to convince the theoretical of electronic ballast. Beside in scope of work for this project followed by:-

1. Studies and development of the PCB design.
2. Studies/learn the appropriate testing and troubleshooting technique.

CHAPTER II

LITERATURE REVIEW

2.1 INTRODUCTION

The first fluorescent lamp was patented over 100 years ago by American inventor, Peter Cooper Hewitt. Cooper Hewitt`s low pressure mercury arc lamp is the direct parent for the generation of today modern fluorescent lamp. Fluorescent lamps are far more efficient than incandescent lamps, fluorescent lamp use electricity to excite molecules of Argon or krypton together with mercury vapor to create luminescence. Unlike incandescent lamps, a fluorescent lamp cannot be connected directly to electric lines. Fluorescent lamp required ballasts to stabilize the flow of current or else they quickly become inoperable. Ballast provides the starting voltage for a fluorescent lamp and limits the current passing through it. The ballast also provides proper electrode or filament heating.

2.2 FLUORESCENT LAMP

A fluorescent tube is a low pressure mercury vapors discharge lamp containing an inert gas that consisting of argon or krypton at low pressure (below 1 atmosphere) plus a small measured dose of mercury. There is a filament at each end which when hot, emits electrons to sustain the discharge when the lamp is operating. The mercury vapors discharge produces ultraviolet light which is converted to visible light by the phosphors coating the inside of the glass tube. The glass blocks the exit of the ultraviolet radiation but allows the visible radiation through.

A non-operating fluorescent tube will appear as an open circuit, since there is no electrical connection from one end to the other. To "strike the arc", a high voltage must be applied across the lamp which will ionizes the gas and this will instantly "cold start" the lamp and shorten its life by sputtering electron-emitting material from its cathodes. However, if the cathodes are first preheated to generate a space charge of electrons at each end of the lamp, the strike voltage is considerably reduced and lamp life will not be unduly compromised by the start-up. As soon as the discharge current flows, the lamp's electrical impedance will drop. It now becomes as negative impedance, where an increase in current is accompanied by a reduction in lamp voltage. Therefore they will be a current-limiting device in series with the lamp which compensates with a positive impedance characteristic to prevent current runaway and rapid destruction of the lamp.

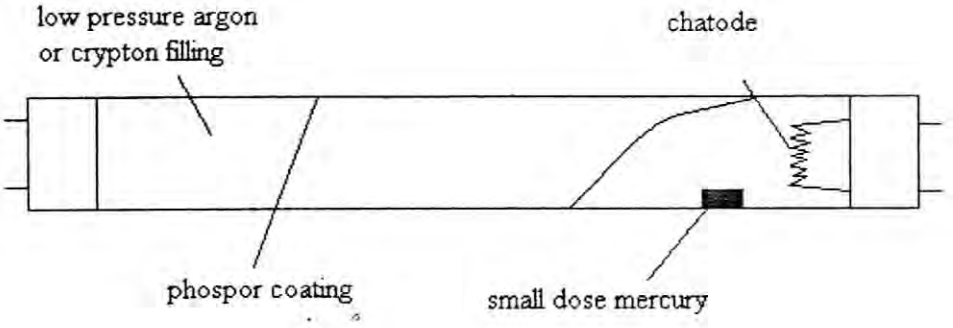

Figure 2.1: Fluorescent Lamp

2.3 BALLAST

Ballasts are electrical devices that convert line current into the proper voltage, amperage, and waveform to operate fluorescent lamps. Electrical distribution systems deliver fixed AC voltage (50 or 60 Hz) and expect connected electrical loads to limit the current drawn from the source. Ballasts provide system stability by limiting the current that can be drawn. Ballasts use inductive and capacitive components because they impede alternating current with little power consumption. Resistive components generate high loss and are usually avoided. The mix of ballasts has been shifting steadily toward more efficient equipment over the past 15 years. Magnetic ballast and electronic ballast are the common ballast that is being use now days.

2.3.1 MAGNETIC BALLAST

The requirements of fluorescent lamp ballast are to:

(a) Preheat the cathodes to induce electron emission,
(b) Provide the starting voltage to initiate the discharge,
(c) Limit the running current to the correct value.

There are several types of mains frequency "magnetic" ballast available. By far the most common circuit for 230V mains supplies has traditionally been the switch start ballast, where lamp ballasting is provided by the choke. Other circuits include, in order of popularity, the semi-resonant circuit and the quick start circuit.

The switch start circuit has been widely adopted because of its simplicity, low cost and improved efficiency when compared with the alternative options mentioned above. Another reason is that the 230V mains voltage is sufficiently higher than the

tube running voltage to allow the use of the simple series impedance ballast in almost all cases.

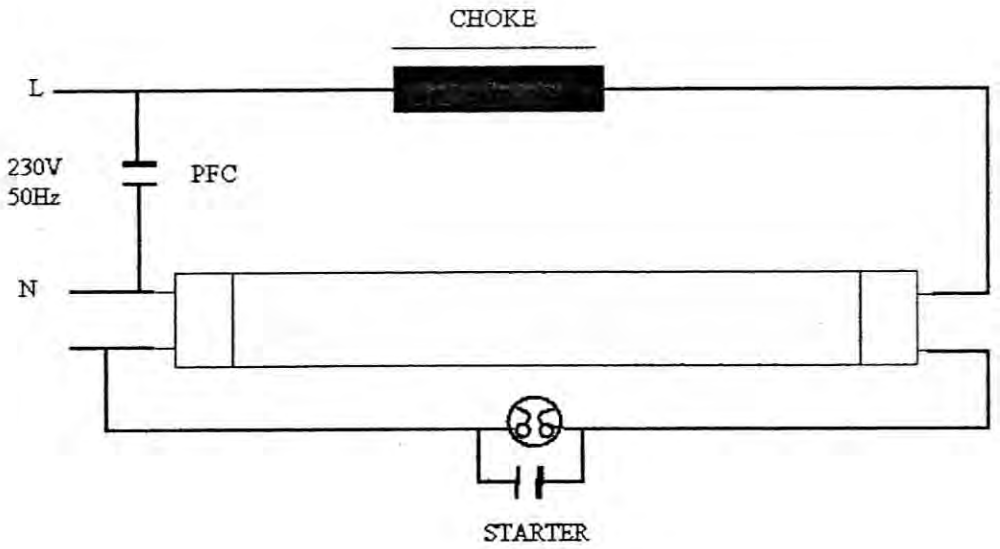

Figure 2.2: A fluorescent tube.

When the voltage is applied to the circuit, the lamp does not operate at first, so the full mains voltage appears across the starter via the choke and lamp cathodes. The starter consists of bi metallic contacts sealed within a small discharge bulb with an inert gas filling such as argon or neon. The mains voltage causes a glow discharge within the starter which heats up the bi metallic contacts, causing them to close. This completes the circuit and allows preheat current to flow through the choke and both cathodes. Since the glow discharge within the starter has now ceased, the bi metallic contacts cool down and open. Because the inductance of the choke tries to maintain current flow, the voltage across the lamp rises rapidly and strikes the lamp. If it does not, the starter's contacts close again and the cycle repeats. Once the lamp has started, the choke controls its current and voltage to the correct levels. The lamp running current is enough to keep the cathodes (heaters) hot and emitting electrons without the need for separate heater supplies, which would otherwise be wasteful of energy. Since the lamp's running voltage is much lower than the mains voltage, there is now not enough voltage to cause a glow discharge in the starter, so it remains open circuit.

2.3.2 ELECTRONIC BALLAST

Electronic ballasts have been available since at least the beginning of the 1980's. Improvements in ballast performance and ever-increasing energy costs have resulted in an upsurge in electronic ballast use since the beginning of the 1990's. Replacing the most efficient low loss mains frequency switch start ballast with electronic ballast leads to reduced energy consumption and improved perfo..nance.

The advantages of electronic ballast are:

1. Increased light output
2. Flicker eliminated
3. Audible noise eliminated
4. Lower ballast power
5. Extended lamp life
6. Versatile lamp control
7. Compact and light weight

2.3.2.1 INCREASED LIGHT OUTPUT

If the operating frequency is increased from 50Hz to above the audible limit of 20 kHz, fluorescent lamps can produce around 10% more light for the same input power. Alternatively, the input power can be reduced for the same light output.

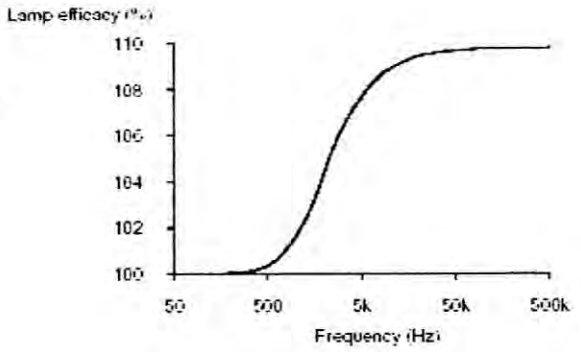

Figure 2.3: Typical fluorescent lamp efficacy

2.3.2.2 FLICKER ELIMINATED

A fluorescent lamp operating at 50/60Hz will extinguish twice every cycle as the mains sine wave passes through zero. This produces 100/120Hz flicker which is noticeable or irritating to some people. If the lamp is operated at high frequency, however, its light output is continuous. This is because the time constant, hence the response time of the discharge is too slow for the lamp to have a chance to extinguish during each cycle.

The output waveform of magnetic ballast will usually be slightly modulated by 100/120Hz "ripple". Figure 2.4 shows the measured voltage and current waveforms of a lamp operating at 60 Hz. After every line zero crossing, the lamp voltage waveform has a restrike voltage peak; during the rest of the cycle, the voltage does not vary much. This causes two big problems: The lamp electrode wearing is significant, and the lamp's output light is highly susceptible to the line voltage, which results in an annoying visible flickering [1].

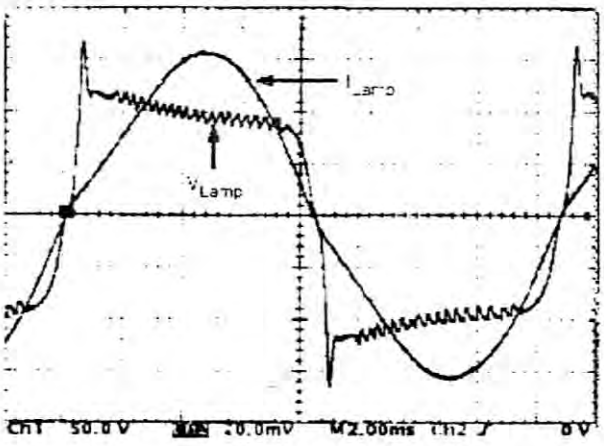

Figure 2.4: Measured lamp voltage and current waveforms at 60 Hz

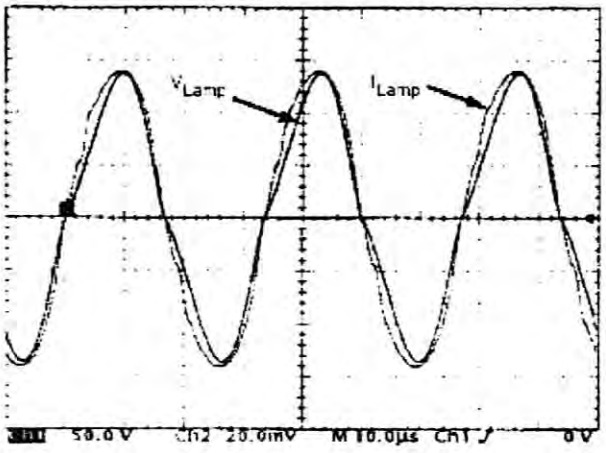

Figure 2.5: Measured lamp voltage and current waveforms at 30 kHz

2.3.2.3 AUDIBLES NOISE ELIMINATED

. Since electronic ballasts operate above the audible range, they do not suffer from the audible noise problems that can occur with mains frequency magnetic ballasts. The familiar buzzing noise of mains frequency choke ballast is caused by

mechanical vibrations in its laminated steel core and, possibly, its coil as well. This can excite vibrations in the steel body of the lighting fixture and the surface to which it is fixed, which amplifies the original noise even further.

2.3.2.4 LOWER BALLAST POWER

Electronic ballast will consume less power and therefore dissipate less heat than mains frequency magnetic ballast. These power reductions are because:

a) At high frequency, the lamp can be run at a lower power for the same light output.
b) The power loss in electronic ballast is much lower than the power loss in mains frequency magnetic ballasts.

2.3.2.5 EXTENDED LAMP LIFE

An electronic ballasts which "soft starts" the lamp will not sputter away the electron-emitting material from the cathodes during starting. This will give longer lamp life when compared to the uncontrolled impulses to which the lamp is subjected in a switch start circuit.