"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 (Power Electronics and Drive)."

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Date : ....7/5/09...

Modeling and Simulating the Magnetic and Electronic Ballast Fluorescent Lamp System

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"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 : ………………………………………
Name : SHARIN BIN AB GHANI
Date : ……………………………………..

Dedicated to my beloved parents;
Ab Ghani Bachik and Rohayati Ibrahim

and friends from Padang Keladi house such as
Imran, Sani, Saiful, Zul, Musa and Jerul.

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In the name of Allah, The Most Beneficent and Merciful. Peace be upon the Messenger of Allah, Prophet Muhammad s.a.w, his companions (r.a) and followers until the end of day. Thanks to Allah, with His blessing, this final project is successfully delivered. First of all, I want to thanks my beloved mom and dad, whom keep prays for me, gives me freedom and show understanding to me as a student because their loves keep me moving forward. Secondly, I want to thanks my supervisor for this final project, Mr Md Hairul Nizam Bin Talib whom shares knowledge and idea so that I will keep on the right track which leads to this project successful. I also want to thanks all technicians and FKE staff who lend me a hand through out this project. Last but not least, to all my friends, thank you for making my life happens.

Wassalam

ABSTRACT

The fluorescent lamp is the most familiar of the large class of lamps referred to as discharge lamps. In these lamps light is created by an electrical discharge within a gas or vapor. They are now used throughout the world, particularly for industrial and commercial lighting, almost to the exclusion of other forms of lighting. The high efficacies, good light output, less output maintenance, wide choice of colour and the very long lives make these lamps ideal for such applications. It has been estimated that about 80 per cent of the world's artificial light is fluorescent. The objective of this research is to analyze and study the system of magnetic and electronic ballast fluorescent lamp; where this magnetic and electronic ballast are the main device to start-up the fluorescent lamp. The research is started by finding parameters such as starting and nominal current, voltage drop and R, L, C values inside the magnetic and electronic ballast fluorescent lamp system by using measuring apparatus such as FLUKE Quality Analyzer, multimeter and oscilloscope. The simulation model is then constructed using simulation software such as Orcad PSpice. The research will include operation, analysis and experimental result of magnetic and electronic ballast fluorescent lamp system.

ABSTRAK

Lampu pendarfluor merupakan sejenis lampu yang selalu digunakan di antara kelas-kelas lampu yang lain dan ia juga turut dikenali sebagai lampu nyahcas. Di dalam lampu ini, cahaya diwujudkan daripada nyahcas elektrik pada gas. Ia telah digunakan di seluruh dunia, terutamanya di dalam pencahayaan sektor indutri dan komersil malah penggunaannya hampir menggantikan ke semua jenis kelas lampu. Pencahayaan yang bagus, kurang penyelenggaraan pada keluaran lampu, pelbagai pilhan warna cahaya dan tahan lama telah menyebabkan lampu pendarfluor sesuai digunakan pada kebanyaka aplikasi. Telah dianggarkan sebanyak 80 peratus lampu buatan adalah jenis pendarfluor. Objektif kajian ini adalah untuk menganalisa serta mengkaji sistem kemagnetan dan elektronik ballast pada lampu pendarfluor; di mana jenis kemagnetan dan elektronik ballast merupakan kaedah untuk menghidupkan lampu pendarfluor. Kajian dimulakan dengan mencari parameter seperti arus pemula dan santai, kejatuhan voltan serta nilai R, L dan C di dalam sistem kemagnetan dan elektronik ballast lampu pendarfluor. Kajian ini menggunakan peralatan pengukuran contohnya FLUKE Quality Analyzer, multimeter dan osiloskop. Model simulasi turut dilaksanakan menggunakan perisian Orcad PSpice. Kajian ini juga turut merangkumi operasi, analisa dan keputusan eksperimen pada sistem kemagnetan dan elektronik ballast lampu pendarfluor.

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CHAPTER I

INTRODUCTION

1.1 Project Objective

This project aims to determine the parameters such as R, L and C inside the magnetic and electronic ballast fluorescent lamp system through experimental and calculation. It also focus the operational circuit for each ballast before proceed to the modeling part. Then it followed by analyze the modeling of the magnetic and electronic ballast fluorescent lamp system using simulation software such as OrCad PSpice. Last but not least, both magnetic and electronic ballasts simulation and experimental results will be compared in term of characteristic performance.

1.2 Problem Statement

Fluorescent lamp is used for almost in our whole life activities. With just a single click on the switch, many of us do not realize the complexity and difficulties to ignite or start-up the fluorescent lamp. Traditionally these lamps have always been operated on AC mains by means of magnetic ballast, which is nothing more than a reactor or choke, for limiting the lamp current. In recent years, as power electronics technology growth, an alternative way of operation was introduced, called electronic ballast, which converts the incoming mains frequency into a much higher frequency, usually in the range of 20 kHz to 80 kHz, to operate the lamp. Unlike the magnetic ballasts, which as a law of physics can follow only one principle of working and only one basic design, power electronics provide a lush choice of design variants and working principles to design electronic circuits for operating fluorescent lamps.

1.3 Project Scope

This project is focused on:

- Identifying the components and parameters of conventional magnetic ballast system by using Pre-Heat Starting for T8 36W Fluorescent Tube 240Vac 50Hz.

- Identifying the components and parameters of electronic ballast system by using Voltage Fed Half-Bridge system for T8 36W Fluorescent Tube 240Vac 50Hz.

- Analyzing the operation of pre-heat and steady-state condition for T8 36W Fluorescent Tube by using conventional magnetic ballast Pre-Heat Starting system.

- Analyzing the operation of pre-heat and steady-state condition for T8 36W Fluorescent Tube by using electronic ballast (Voltage Fed Half-Bridge) system.

- Analyzing the modeling of the magnetic and electronic ballast T8 36W Fluorescent Tube system using simulation software such as OrCad PSpice.

- Comparing of actual and simulation result in point views of performance magnetic and electronic ballast system.

- Improving the magnetic ballast performance system.

1.4 Report Outline

In this project report, it consists of six chapters altogether. Chapter one gives an introduction about this project. Chapter two provides the literature review of this project where its reviews the method to ignite fluorescent lamp system using magnetic and electronic ballast. Project background will be discussed in chapter three with explanation of principle construction of fluorescent lamp, magnetic ballast system operation and lastly the electronic ballast system theoretical and operation. Chapter four consists an explanation of methodology to accomplish the project. In chapter five, all the result of the magnetic and electronic ballast system will be discussed in term of experimental, calculation and simulation. Finally in chapter six, provides the conclusion and recommendation of this project.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction of Fluorescent Lamp

In the year 1936 to 1937, the fluorescent lamp tube has been invented by group of scientists. In the year 1938, the fluorescent lamp tube technology was commercialized by General Electric Company in United States with various types from 15W to 30W. The fluorescent lamp tube consists of glass tube filled with argon or krypton gas at low pressure. A small amount of liquid mercury, which will vaporize when warmed by an initial low-energy arc in the argon or krypton gas, is also enclosed. Inside the lamp, it coated with various phosphors which emit the desired visible light when irradiated with ultraviolet light generated by a high-current mercury arc flowing through the lamp. The high arc current is drawn through the lamp by a high voltage applied across electrodes at each end [3, 4, 8].

Before electrodes voltage is applied, there are relatively few current carriers in the lamp, as none of the gas molecules are ionized. The current carriers will be supplied in quantity when a few free electrons in the gas are accelerated to high speeds by the voltage across the end electrodes. An accelerated electron, colliding with a neutral gas atom, ionizes it, providing a free electron and a massive positively charged ion. The electron accelerated toward the anode and the positive ion toward the cathode now produces the more ionization by collision. Each collision produces more current carriers, and each current carrier causes more ionizing collisions. An avalanche of current or arc results happen [3].

During this emissive period, the filaments increase the electron population in the tube, and consequently decrease the avalanche potential resulting in a lower striking voltage for the lamp. Once the lamp is struck, it maintains a quasi-constant voltage across its end points. This value is called the arc voltage. A practical value for the cold striking voltage for a 5 foot lamp (58W) is near the kV range with the corresponding arc voltage around 110Vrms. A fluorescent lamp can be operated at low or high frequencies. At low frequency, e.g. in a 60 or 50Hz ballast application, the conducting gas reacts faster than the AC line. Every time the polarity of the mains changes, the lamp current cancels and the tube halts its conduction process [10].

2.2 The Ballast for Fluorescent Lamp

The fluorescent lamp is a constant voltage device. For a given tube length, the voltage across the arc remains the same, regardless of the current. After the initial arc has been struck, more atoms ionized and without something to prevent it, the current would build up until the circuit fuse failed or the tube exploded. To prevent this situation from disrupt any of the instrument, a device to limit the current through them should be used, and this is referred to as a ballast. Ballast based of two principal kinds, electromagnetic ballast and electronic ballast [5].

2.2.1 Electromagnetic ballast

The simple reactor-type, electromagnetic lamp ballast consists of a core and coil assembly, to which is often added a capacitor to correct the line power factor. Other electromagnetic lamp ballasts are basically a modification of the reactor’s ballast construction. All ballast design must be compromise of size, weight, shape, performance and cost. It must have a long life, produce a minimum of hum and have a low power loss. There is a constant demand by luminaire manufacturers for ballasts of increasingly smaller dimensions as they seek to make the luminaire units become smaller and compact in size [4].

2.2.1.1 Classifications of Electromagnetic Ballast Starting Method

There are different types of ballast to drive the fluorescent lamp. The types of ballast required based on specific type of the fluorescent lamp. The types of lamp and ballast depended to the method of starting and operating condition. It can be divided into six methods in order to drive the fluorescent lamp [1, 4].

a) Pre-heat starting or Glow starter

This method is using the conventional starter. Here a current is passed through each cathode for a short time prior to the striking of the arc. Once the tube is running the cathode temperature is maintained by bombardment and no separate heating current is required. The pre-heat starting method will be discussed with more details in this project, as representing an electromagnetic ballast system [4, 5].

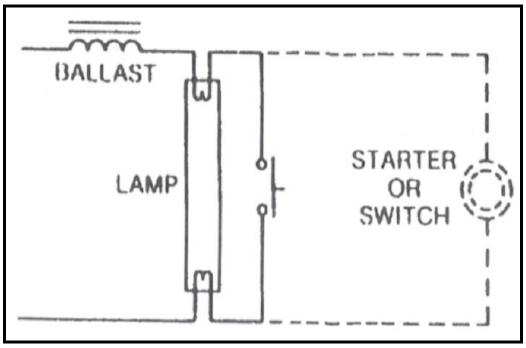

Figure 2.1: Pre-heat starting method diagram [4].

b) Lead-lag Circuit

Almost at the very onset of fluorescent lamp usage, it was found desirable to operate two lamps from the same ballast. One of the lamps is connected in series with an inductor, while the other lamp is in series with a capacitor, plus an inductor, which is still needed to help limit the current. The overall circuit will then provide a power factor close to unity [4].

c) Rapid Start Circuit

This method was developed to provide the desired quick starting of the instant start circuit with the economy and size of the pre-heat ballasts. A low-voltage transformer is added to the ballast to provide continuous heat for the filaments. Such circuits usually have a capacitor in the circuit to help develop the starting voltage. In energy efficient rapid start circuits there maybe an arrangement to disconnect the cathode heating once the tube has started. Rapid start lamps require a grounded conducting plat within about 12mm of the tube (usually the luminaire structure) for reliable operation, and are silicone coated to reduce the effect of humidity [5].

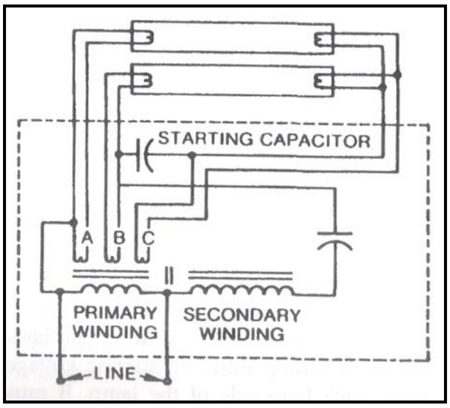

Figure 2.2: Example of Rapid start circuit diagram [4].

d) Instant Start Circuit

A better instant start circuit was developed to overcome the nuisances of the pre-heat lamps such as slow-starting, blinking and starter maintenance. It is most used for operate slimline lamps, which have just one terminal on each lamp end, rather than the customary bi-pin construction that is needed for pre-heated lamps. Here no heating current is applied at all, and starting relies on a high enough electric field being created in the lamp. This method of starting seems to shorten the lamp life because of it usage of high open circuit voltage for starting the lamps [3, 4, 5].