SELF-POWER LIGHTING AND WIRELESS CONTROL ROAD DISPLAY SYSTEM

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DECLARATION

"I hereby declare that the work in this dissertation is my own except for quotations and summaries which have been duly acknowledged."

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SUPERVISOR DECLARETION

"I hereby declare that I have read this thesis and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Electronic (Telecommunication Electronic)"

Signature : ……

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ABSTRACT

Energy harvesting is a process of electrical energy transformation by which the energy is originated from external sources such as solar power, thermal energy, wind energy and kinetic energy, captured and stored for the low power electronic application such as microelectronic devices for wireless sensor network. Energy harvesting can save a lot of energy by converting the surrounding energy into usable energy for other applications. For this project, the energy harvesting mechanism is focused on converting impact(kinetic energy) from the one produced by moving vehicle on the road into electrical energy using piezoelectric and the energy generated will be used on the radio frequency switch which for controlling a display system. Input energy produced by piezoelectric is very small and unable to use by applications, therefore a circuit system required to be modified in order for the input energy to be applied on radio frequency switch. A prototype is developed to demonstrate the self powered sources using piezoelectric applied on wireless control road display system. The prototype was designed to be suitable for the application in such way that the piezoelectric component would not be exposed to excessive impact by introducing absorber on the system. In order for powering power hunger RF transmitter, therefore an amplifier circuit was designed to convert the AC output generated from piezoelectric.

ABSTRAK

Penuaian tenaga adalah satu proses transformasi tenaga elektrik, tenaga itu berasal dari sumber-sumber luar seperti tenaga solar, tenaga haba ,tenaga angin dan tenaga kinetik, tenaga tersebut dikumpul dan disimpan untuk penjanaan kuasa untuk elektronik yang bertenaga kecil seperti peranti mikroelektronik untuk rangkaian pengesan tanpa wayar. Penuaian tenaga boleh menjimatkang banyak tenaga dengan menukar tenaga di sekeliling kepada tenaga yang boleh digunakan untuk aplikasi lain. Dalam projek ini, mekanisme penuaian tenaga member tumpuan di impak (tenaga kinetik) dihasil dengan kenderaan yang bergerak di jalan raya kepada tenaga elektrik dengan menggunakan piezoelektrik dan tenaga yang dijanaakan digunakan pada frekuensi radio suis untuk mengawal system paparan. Masukkan tenaga yang dihasilkan oleh piezoelektrik adalah sangat kecil dan tidak dapat digunakan untuk aplikasi, oleh itu system litar perlu diubahsuai untuk membolehkan kemasukkan tenaga yang akan dapatdigunakan pada frekuensi radio suis. Prototaip dibinakan untuk mendemonstrasikan sumber berkuasa sendiri dengan menggunakan piezoelektrik digunakan pada kawalan tanpa wayar system paparanjalan. Prototaip ini direka dengan sesuatu cara supaya komponen piezoelektrik tidak akan terdedah kepada kesan yang berlebihan dengan memperkenalkan penyerap dalam system ini. Untuk membekalkan kuasa kepada pemancar RF, litar electric telah direka untuk menukar pengeluaran AC yang dihasilkan daripada piezoelectric.

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ABBREVIATION LIST

PZT	Lead ZirconateTitanate
AC	Alternate Current
DC	Direct Current
LED	Light Emitting Diodes
RF	Radio Frequency
A/D	Analog to Digital
Ga	Gallium
As	Arsenic
P	Phosphorus
GaAs	Gallium arsenide
GaP	Gallium phosphide
GaAsP	Gallium arsenide phosphide
Hz	Hertz

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Self-power road display system based on impact type energy scavenger is an energy conversion by change kinetic energy (impact) to another form of energy (electrical energy) for application of road display system without adoption of electrical energy supply from power station. Thus, this field of self-generated energy source had been growing tremendously. Normally display system is powered up by the electrical energy supply from power station or batteries, electrical energy supply from power station for long term will be costly. Therefore, it had been replace with self-power energy sources which the renewable energy are self generate to prevent use of energy from power station to save the cost of electrical energy and conserve the natural environment and resources. The field of this project is to develop a self-generated energy source which can sustain the electrical energy to road display system. This project will focus on development of self-generated system which suitable with application on the road, circuit to modify the ac sources from piezoelectric and road display system. Piezoelectric is used to generate energy by receive impact from on road vehicle to produce electricity and design circuit to modify the ac source to be usable for RF transmitter. Aprototype developed to demonstrate the self generated source applied on wireless control road display system.

1.2 PROBLEM STATEMENT

Road display system display the instruction to deliver the message by using electrical energy, however the energy produced by using piezoelectric is very small. Since circuit is design to be parallel, current produce by piezoelectric not sufficient for the circuit. Design structure of piezoelectric install in bumper to be able to harvesting sufficient power for road display system and design circuit for temporary battery for the power to discharge optimum to prevent energy wasted or excess voltage on LED. Piezoelectric cannot ensure that energy is always flowing from mechanical part to electrical part since the impact of vehicle not continually [1, 2].

1.3 OBJECTIVE

This project emphasizes on development of a self-powered road display system based on impact type energy by using piezoelectric as power source. Few stages in self-powered road display system needed to convert AC source from piezoelectric to DC source which suitable with the road display system. Thus, the objectives of this project are as follows:

i. To design an on the road self-powered source by using piezoelectric.
ii. To design circuit for modify the ac sources from piezoelectric to be usable for RF transmitter.
iii. To analyze the performance of self-powered road display system
iv. To develop prototype.
v. To demonstrate the prototype of self powered wireless control road display system.

1.4 SCOPE

Scope of this project is on structural design for energy harvesting road display system by using piezoelectric based on impact type energy scavenger. This project is conducted in laboratory with an intention to develop a prototype for demonstrating the basic concept of energy harvesting[3, 4, 5].The material of

harvesting energy being used in this project is off-the-shelf piezoelectric obtained from PIEZO SYETEM, INC with the size of 20.25cm^2 with the thickness of 0.5cm. Power generated by the energy harvester is in the range of 100μV up to 3.69V. Electrical energy of radio frequency (RF) transmitter is within the range of electrical energy generated by the piezoelectric material.

1.5 PROCEDURE OF THESIS

Procedures of thesis for this research are as follow:

i. Perform literature review
ii. Understand the concept of piezoelectric such as feedback of piezoelectric when applied mechanical force on piezoelectric
iii. Develop of self powered source using piezoelectric, design circuit to modify the ac sources from piezoelectric and road display system.
iv. Simulation on self-powered road display system
v. Fabrication of self-powered road display system
vi. Perform power analysis on piezoelectric and performance of the self-powered road display system.

1.6 THESIS STRUCTURE

Summary of each chapter for this dissertation as follow:

Chapter 2

This chapter presents the review of related literature review. This includes basic understanding of each stage function of circuit that needed to carry out this project.

Chapter 3

This chapter introduced the whole methodology of the project starting from structural design for piezoelectric, circuit to modify the ac source from piezoelectric, method to measure and simulation of the project.

Chapter 4

This chapter presents the result obtained from simulation and hardware on the performance of piezoelectric and road display system. Results obtained for all the analysis are shown and discuss in this chapter.

Chapter 5

This chapter presents the conclusion of the results obtained from the analysis of self-powered road display system in term of the self powered product that are workable through energy scavenger. Suggestion on future works that can be done to improve the result also discussed in this chapter.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This project focused on the development of self powered source using piezoelectric and circuits that modified the source produce by piezoelectric into suitable input power. This chapter describes the basic understanding that is needed in executing this project.

2.2 SELF-POWERED SOURCES

Nowadays, there are many types of self powered sources that can be used for energy harvesting in different kind of energy form such as vibration (kinetic energy), sunlight (solar energy), water flow (potential energy), temperature (heat energy) and impact (kinetic energy). In this project, since the application is on the road, thus impact is chosen as the self powered sources since there is impact produces by vehicle during pass through the developed self powered sources of this project. Piezoelectric is chosen as the sources that convert the impact (kinetic energy) into electrical energy.

2.2.1 PIEZOELECTRIC

Piezoelectricity has been widely studied since Curie discovered it in 1880. Longitudinal, transverse, shearing, bending and torsional effects of piezoelectric were discovered so far [6], where all the piezoelectric effects occur. Piezoelectric effect is the ability of certain materials such as crystals or certain ceramics to generate an AC (alternating current) voltage when subjected to mechanical stress or vibration or generate the vibration when subjected to an AC (alternative current) voltage[7, 8]. Besides that, piezoelectric effect also describe as the link between electrostatics and mechanics. The most common piezoelectric material is quartz. Lead ZirconateTitanate Piezoelectric (PZT) Ceramics is using as self powered sources in this project[11].

2.2.1.1 Lead ZirconateTitanate Piezoelectric Ceramics

Piezoelectric ceramics had been used in mmany application such as buzzers and sensors because of the lead zirconatetitanate (PZT) piezoelectric ceramics outstandingcharacteristic [10]. Lead zirconatetitanate (PZT) is an important ceramic material with excellent dielectric and piezoelectric properties [9].There are few applications using these technologies (piezoelectric effect) such as ignition systems, actuators and sensors.However the electrical energy produce by piezoelectric effect is very limited, thus the usage of electrical energy is carefully arranged. Due to the capability of piezoelectric that can produce electrical energy although the amount very small, however the small amount of electrical energy can apply on microelectronic elements which had been discussed by Okayasu et al [12].

Figure 2.1: Lead zirconatetitanate ceramic piezoelectric

Figure 2.2 shows the model circuit that represents the material of ceramic piezoelectric by using the electric components to replace the material.

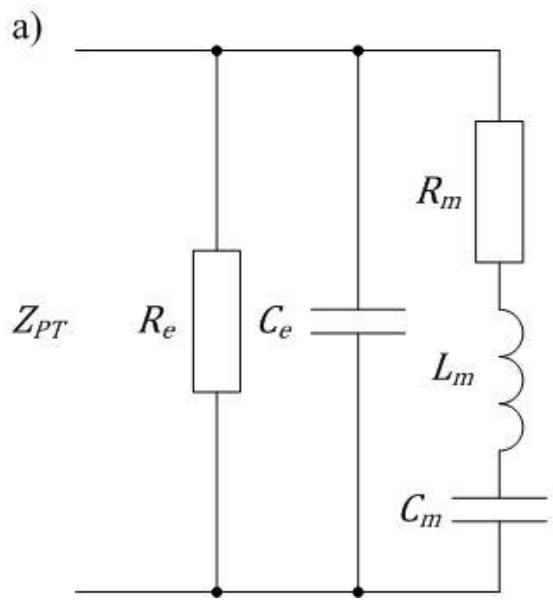


Figure 2.2: Model circuit for ceramic piezoelectric [21]

Mechanical constitutive equation that applies for piezoelectric,

Strain = Compliance * Stress:

$$S = s * T$$

Piezoelectric materials are concerned with electric properties with consider the constitutive equation for common dielectrics,

Charge Density = Permittivity * Electric Field:

$$D = \varepsilon * E$$

Mechanical constitutive equation combines with electrical constitutive equation, coupled equation:

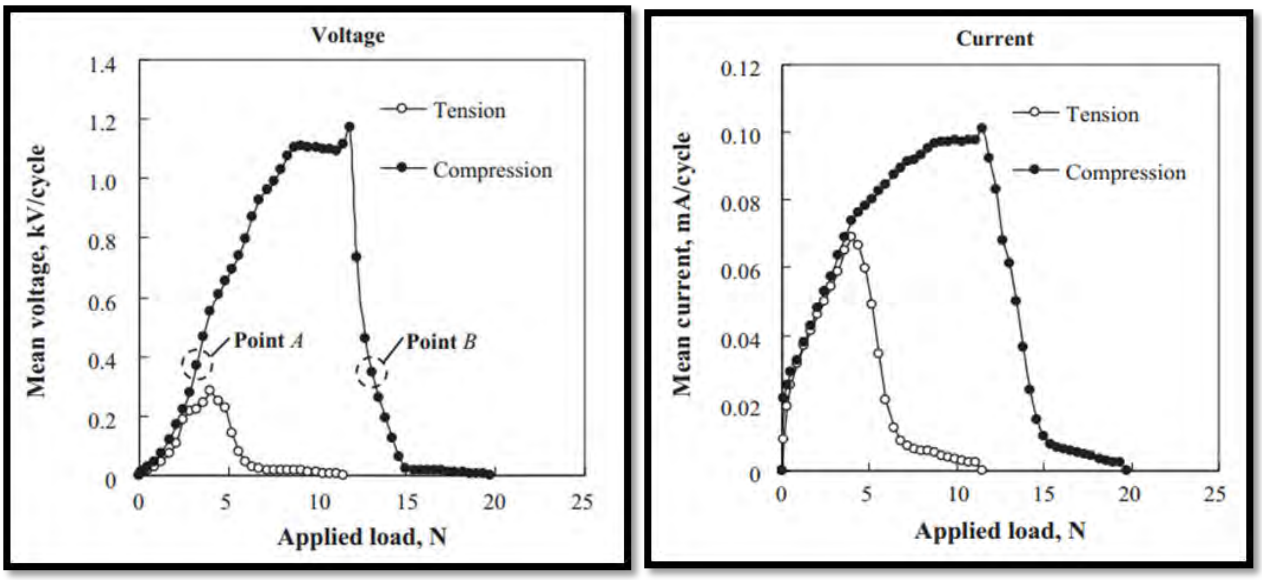
$$D = \varepsilon E + [d_{3x}]T$$

$$S = sT + [d]E$$

Where $[d_{3x}]$ is the matrix for the direct piezoelectric effect and [d] is the matrix for the converse piezoelectric effect [20].

Ouput voltage can be calculate by using formula below which represent the output power generated during piezoelectric effect,

$$V = \frac{D}{Q} = d_{3x}T$$



a) Variation of mean voltage

b) Variation of the mean current

Figure 2.3: a) Variation of mean voltage and b) Variation of the mean current[12]

2.3 RECTIFIER

Rectifier contain of p-n junction which only allow sources flow only in one direction can convert the AC sources to DC voltage after electrical energy pass through the rectifier. Rectifier will be active when forward biased and the rectifier will off when reverse bias. Therefore, positive cycles of AC sources will across the rectifier because of forward bias and the negative cycle of AC sources will not conduct through rectifier because of reverse bias. Thus only positive cycle of electrical energy will be conduct. If the resistance is connected in series with the diode, the output voltage across the resistance will be unidirectional DC. Thus rectifier isused on an AC voltage to rectify alternating voltage to a pulsating DC voltage.

2.3.1 Bridge Rectifier

The bridge rectifier circuit is using four diodes to form a full-wave rectifier circuit by connecting four diodes as in figure 2.4. To one cater-corned of the bridge, the ac voltage is applied through a transformer if necessary and the rectified DC voltage is taken from the other diagonal of the bridge,AC voltage is directly applied to the bridge.

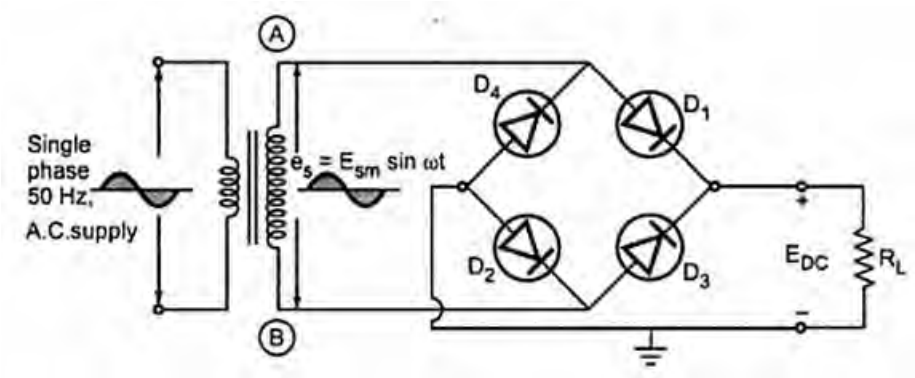


Figure 2.4: Bridge rectifier circuit [13]