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I/We* hereby declare that I/We* have checked this thesis/project* and in my/our* opinion, this thesis/project* is adequate in terms of scope and quality for the award of the degree of *Doctor of Philosophy/ Master of Engineering/ Master of Science in ....

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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LIST OF SYMBOLS

A	Area
ω	Vibration frequency
E	Electromagnetic induction
N	Number of turn
B	Magnetic flux
V_{in}	Input voltage
V_{out}	Output voltage
V_b	Voltage boosted
D	Duty cycle
L	inductor
C	Capacitor
F	Frequency
mV	Milivolt

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ABSTRACT

A vibration Energy harvester was designed and fabricated. A proper boost converter is designed for the harvester, and then the output voltage of the boost converter is tested with several changes on the shaker parameter. The manipulating variables that were used during this project were frequency of vibration and the shaking time. The frequency used in the experiment is 4.43Hz, 5.58Hz and 6.58Hz.Whereas the time of shaking is 1minute, 2minutes, 3 minutes, 4 minutes and 5 minutes. The type of permanent magnet used is Neodymium Iron Boron. The diameter of permanent magnet used is 20mm and the thickness of the magnet is 5mm. The diameter of coil used in this project is 0.35mm, while the number of coil turn is 1000 turn. The maximum voltage3 can be achieved for the designed harvester is 1.31V at 6.58Hz for 5 minutes. From the results it can be concluded that increasing the time of shaking and frequency can increase the voltage output further higher.

ABSTRAK

Satu penjana tenaga melalui getaran telah direkabentuk dan difabrikasi.Satu litar electrik untuk meningkatkan voltan daripada penjana itu juga telah direkabentuk dan difabrikasi.Litar tersebut telah diperiksa dengan mengubah beberapa pembolehubah.Antara pembolehubah dalam projek tersebut adalah, frekuensi getaran dan masa getaran. Frekuensi getaran yang telah digunakan dalam ujikaji ini ialah 4.43Hz, 5.58Hz dan 6.58Hz.Manakala,masa getaran yang telah ditetapkan ialah,1minit , 2minit ,3 minit , 4 minit and 5 minit. Magnet yang digunakan dalam projek ini ialah Neodymium Iron Boron. Magnet yang digunakan mempunyai diameter sebanyak 20mm dan ketebalan sebanyak 5mm.Gegelung tembaga mempunyai ketebalan sebanyak0.35mm dan sebanyak 1000 pusingan telah dibuat keliling penjana tersebut.Voltan maxima yang boleh dicapai pada frekuensi 6.58 dalam masa 5 minit ialah 1.31V.Melalui experimentasi yang dibuat,kita dapat memahami,bahawa voltan penjana akan meningkat apabila frekuansi dan masa geteran meningkat.

CHAPTER 1

INTRODUCTION

1.1 Project Background

This project is all about designing a boost converter for experimental study of an energy harvester. Energy harvesting is a process of energy scavenging from the surrounding environment. There are so many methods to harvest energy from the environment such as harvesting electricity from the waste heat released from any system, thermoelectricity, mechanical motion of oceans waves, and some more(Faruk,2007).The energy that can be harvested make wireless system to be battery independent.

Nowadays the technology becomes more advanced and the system starts to become smaller. However, the energy needed to supply the portable devices is still not enough to power them. Scientists continue to research on high density batteries but still the power produced is finite and low, which reduce the life span of the system. The electronic devices that can work in long term have more advantages in a system which limits accessibility.

The application of vibration energy harvester in our life is well discussed (Seah & Eu, 2009).There are several categories for the vibration harvester such as electrostatic (Balato, 2015), piezoelectric (Sodano & Inman,2004), (Zhang,2014) and (Saadon, 2011) and electromagnetic(Glynne-Jones, 2004).However, this paper only based on the research of vibration power harvester. Figure below shows on of the schematic of electromagnetic power harvester. The current actually is induced by the magnetic field of the magnet which induces EMF in the coil (Williams, 1996).However, electromagnetic vibration energy harvesters can only produce small amount of voltage usually less than 1V and it's not able to power up a household or even a normal circuit such as a cell phone powered by a single cell. An electrical circuit is needed to extract, convert, and condition the harvested voltage to be utilized by the load. This paper presents the design, implementation of a DC–DC boost converters which step up the lower voltage produced by the vibration energy harvester to higher voltages and experimental study on the vibrational energy harvester.

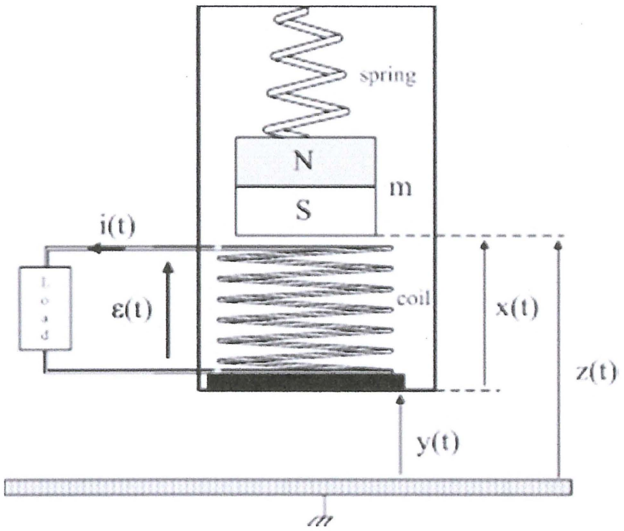

Figure 1.1 Schematic of electromagnetic power harvester

Source: Balato (2017) .

1.2 Problem Statement

Energy harvesting is a technology that has been widely used in our world. There are so many ways to harvest energy from the environment for example electromagnetic vibration, ocean waves, solar power or even wind energy. In this project, vibration energy harvesting has been selected as the main energy harvesting source. The challenge of using vibration energy harvester is that, the output from vibration energy harvester is very low and not suitable to power up even a single cell powered phone. Thus, we need an electrical circuit to improvise the output from the vibration energy harvester.

Moreover, electrical devices always need a constant power supply for example a phone battery with 5v charging requirement need constant supply of 5v to be charged fully and supplying with variable power wont charge the phone. Same goes for the outputs from the vibrating energy harvester. Since the environment is not constant and the ambient energy changes according to the time variances, we need to make constant outputs which can supply electrical devices. Other than that, the vibration based energy harvester can only operate in low frequency characteristic of 1 Hz to few kHz. Thus optimum operating conditions for the harvester that can produce maximum output voltage have to be determined.

1.3 Project Objective

The objective of this paper is briefly explained below:

- To optimize the energy Harvested through DC-DC boost converter using PWM method.
- To design and fabricate a Vibration Energy Harvester.
- To analyze the Voltage output of the boost converter by varying different parameters of the Harvester.

1.4 Scope of the Project

The project scope could describe a project of a lot larger size than intended so a set of delimitations are set up. There are many ways of harvesting energy. One can extract energy from almost all kinds of processes and force, e.g. Chemical, kinetic etc. In this project it is chosen only to focus on the vibration energy sources. The number of turn and type of magnet used in this vibration energy harvester is constant. The boost converter obtains developed using MOSFET, diode and more convenient components. Thus, the experiment conducted is only based on different number of magnet and shaker frequency.

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