UNIVERSITI TEKNIKAL MALAYSIA MELAKA

PSM TITLE:
DESIGN AND DEVELOPMENT OF WIRELESS POWER TRANSFER FOR IMPLANT BIOMEDICAL DEVICE (PTIBD)

This report is submitted in accordance with the requirement of Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electronic Engineering Technology (Industrial Electronic) with Honours

by

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2015

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **Design and Development of Power Transfer for Implant Biomedical Device (PTIBD)**

SESI PENGAJIAN: **2014/ 2015 Semester 2**

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I hereby, declared this report entitled "Design and Development of Power Transfer for Implant Biomedical Device (PTIBD)" is results of my own research except as cited in references.

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfilment of the requirements for the Universiti Teknikal Malaysia Melaka (UTeM) the Bachelor of Electronic Engineering Technology (Industry) with Honours (JTKEK). The member of supervisory is as follow:

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ABSTRAK

Melalui satu saluran transcutaneous iaitu beraruhan penghubung telah memberi kuasa kepada alat peranti tempelan bioperubatan seperti koklear tempelan, retina prosthesis dan juga perentak jantung. Perentak jantung akan menghasilkan peransangan elektrik ke jantung secara berperingkat untuk mengawal denyut pemasaan pengecutan jantung. Perangsangan elektrik adalah berbentuk dedenyut kekacang dihasilkan oleh bateri perentak jantung yang perangsangan elektriknya akan disalurkan pada tisu jantung melalui satu rod atau lebih rod dimana rodnya akan bersambung dengan perentak jantung melalui yang penebat konduktor anjal. Penebat konduktor dan seangakatan dengannya adalah dirujuk sebagai plumbum. Pada masa kini, perkembangan dalam bidang penciptaan teknologi bateri hanya menggunakan bateri jenis Lithium. Akan tetapi, voltan bateri perentak jantung akan berkurangan dengan masa penggunaanya dan tidak dapat menghasilkan kuasa kepada perentak jantung. Dengan itu, perentak jantung tidak dapat menghasilkan perangsangan elektrik. Pengecas ini direka mempunyai dua bahagian iaitu bahagian luar dan bahagian dalam pada perentak jantung. Bahagian luar direka untuk membolehkan penghantaran kuasa kepada bahagian dalam. Bagi mengatasi masalah ini pengecas sangat diperlukan. Projek ini membolehkan pemindahan kuasa antara luaran ke dalaman. Pengecas khas yang direka dapat membantu mengecas bateri dalam alat peranti tempelan melalui luar badan tanpa menggunakan wayar. Input dan output voltan telah diambil. Hasil kajian mendapati nilai voltan pada litar luaran adalah tinggi daripada nilai voltan litar dalaman iaitu dari 12 V ke 5 V. Hasil dapatan perubahan bentuk gelombang keluaran dan voltan berubah-ubah dari litar luaran ke litar dalaman kerana voltan menurun kurang daripada 5 V pada pengubah dalaman untuk memindahkan kuasa ke peranti tempelan. Reka bentuk ini dicapai apabila pengubah boleh memindahkan lebih kuasa dan mempunyai keupayaan untuk mengecas peranti yang diimplan.

ABSTRACT

Through a transcutaneoues inductive link has been give power for implanted biomedical device such as a cochlear implant, retinal prostheses and pacemaker. Cardiac pacing involved the electrical stimulation of the heart in order to control timing of the contraction of the heart. In form pulses, the electrical stimulation is generated by a battery powered pacemaker and applied to the tissue of the heart by one or more electrode that one connection to the pacemaker via flexible insulated conductor. In general, the insulated conductors and associated electrodes form is refer to as the "lead". Nowadays, battery lithium is used because it is the latest development. This battery has been installed in pacemaker but unfortunately, the battery's power of pacemaker becomes less with time and cannot regenerate the power again to the pacemaker. Hence, the pacemaker cannot generate electrical stimulation. To overcome this problem, a charger was needed. The special charger that has the ability to charge the battery of implant device from outside the body was designed. The external part was designed for the transferring of power to the implanted part and can charge the battery implanted device without using wire. The voltage input and output has been taken. The result shows that the output voltage of primary transformer is highest value than the output voltage of the secondary transformer which is from 12 V to 5 V. Result shows the changing of output waveform from primary transformer to secondary transformer get a movement and has the changing voltage from primary side circuit to secondary side circuit because voltage decreased less than 5 V at secondary transformer to transfer power to implant device. This design was achieved when transformer can transfer more power and has the ability to charge the implanted device.

DEDICATION

Dedicated to my father, Salleh bin Baharum and my mother, Hasnah binti Othman. To my supervisor, Mr A Shamsul Rahimi bin A. Subki, all my lectures and friends. Thanks and appreciated for their help and support me.

ACKNOWLEDGEMENT

First and foremost, I would like to express my appreciation to my supervisor, Mr A Shamsul Rahimi bin A. Subki for the guidance, enthusiasm and also motivation given throughout the progress of this project. My appreciation also goes to my family who has been so tolerant and supports me all these years. I will always remember about this. By the by my awesome gratefulness committed to my closest companion Adi Khairi Bin Abdul Latif and BETE member's batch 2012 who had given me the valuable supports. Finally, I want to appreciate to a person that involved directly or indirectly that helped me and much forgiveness on my mistakes during my period for finishing my PSM.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

PSM	- Project Sarjana Muda
PTIBD	- Power Transfer Implant Biomedical Device
BJT	- Bipolar Junction Transistor
FET	-Field Effect Transistor
Vs	- Voltage Source
Vs	- Secondary induces voltage of ideal transformer
Vp	- Primary induces voltage of ideal transformer
Ns	- Number of turn in the secondary coil
Np	- Number of turn in the primary coil
Tm	- Mark time (output high)
Ts	-Space time (output low)
t	- Time
T	- Period
f	-Frequency
DC	- Direct Current
AC	- Alternating Current
V	- Volt
Ω	- Ohm
μ	- Mikro
k	- kilo
M-	- Mega
SCR	- Silicon Controlled Rectifier
Vdc or Vav	- the average or DC output voltage,
Vp	- the peak value of half wave,
Vrms	- the root-mean-square value of output voltage.
π	- Pai
e	- Exponent
pk-pk	- peak to peak

CHAPTER 1
INTRODUCTION

1.1 Background

In medical device, pacemaker provided an electrical stimulation to heart and controls the heart's rhythm. Cardiac pacing involved the electrical stimulation of heart to control timing of the contraction of heart. One or more electrodes will one is connected to the pacemaker via flexible insulated conductor to produce electrical stimulation by generated battery power of pacemaker. In general, the insulated conductors and associated electrodes form is refer to as the "lead". Now, a type of battery Lithium is used because it is the latest development. The battery Lithium has been installed in medical device such as pacemaker. In operation of pacemaker is described that the electrical stimulation is generated can effectuated capture. The term "capture" is referred to ability of a given stimulation signal generated by a pacemaker to cause depolarization of myocardium effect to heart muscle to contract or the heart to beat. Stimulation signal has been effective if no need for bulky pump and output capacitor, this case pulse generator is needed. The pulse generation should minimize the amount of energy needed to deliver. The stimulation signal decreases the polarization effected around the electrodes. In addition, the pulse generator must be isolated from the heart to eliminate the need for an output decoupling capacitor. The focus of this project is to design a circuit that can transfer power to implanted biomedical device. The circuit has two sections which is external part and internal part. Firstly, this project needs to design the external part that consists of oscillator circuit, power drive and the primary side of the transformer. Secondly, the project need to design the internal part consists of secondary side of transformer, rectifier, voltage regulator that will be used to charge the battery of the pacemaker

1.2 Problem Statement

Nowadays, many devices for implanted biomedical just have battery to maintain the power. The battery was functions only in below 10 years. Now, the project is created to help the devices always work even if the battery is dead. Besides that, implanted biomedical devices such as pacemaker must have power to generate electrical stimulation. It is not easy to transfer power because it resides inside the human body. Based on this problem, the project must be designed circuit to supply sufficient power to the battery of pacemaker inside the body. This project has two circuit had been created which is external and internal circuit. External part is a function to transmit power. Internal part is function to receive power from external and recharges the battery in implant device. Expected result for this project is transformer can transfer more power and has the ability to charge the implanted device.

1.3 Objective

This objective of this project is must be able:

1. To design a power transfer circuit between external and internal part.
2. To analysis the input and output voltage at external and internal circuit of PTIBD

1.4 Scope

Scope of this project is to develop the charger battery for pacemaker. Firstly, circuit of charging battery must designed external and internal circuit. External circuit comes from outside the body and internal comes inside the body. Circuit from external side can transfer power to pacemaker device. From internal side it can get the power to recharging battery to pacemaker. This is called wireless power transfer. Next, the data must collected based on analysis the input and output voltage at external and internal circuit of PTIBD

1.5 Structure/Summary of this Report

This report has five chapter must included. First chapter is discusses about objectives and scope. Second chapter was discusses about the theoretical or sample of literature review based on research. Chapter three is about methodology of design of circuit, fabrication process and analysis using software. Continues the chapter four the founded data from analysis result and must listed for doing discussion. Lastly, chapter five is the overall process based on observation which was concluded during this project.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction of Literature Review

This chapter was researches about theory related to the project based on journal, book or other references. Begun, to characterize the hardware and related law sample wireless power transfers.

2.2 History about Battery in Pacemaker

Has reported in worldwide about that 600,000 pacemakers are embedded and the aggregate number of individuals utilized with various sorts of introduced pacemaker has been crossed 3 million clients. Pacemaker is used half of its battery power for cardiovascular pacemaker instigation and the other half for routine exercises. The crucial history about batteries in cardiovascular pacemakers is utilized nickel-cadmium rechargeable battery. Next zinc-mercury battery was made and just life is which proceeded for more than 2 years. At 1972, Wilson creates the best batteries because survived period for battery life was taking a long time. The pacemaker unit goes on an electrical heartbeat with the best energy to the best area to vitalize the heart at a favoured rate

The heart pacemakers fuse a heartbeat generator and a lead framework. Beat generator house electrical device responsible for making the beat by system for yield circuits at the best time by technique for timing and control circuits in light of occasions distinguished by strategy for perceiving circuits. It additionally contains a

force supply (battery) and solidified substitute parts. The pacemaker unit is typically introduced in the pectoral zone (Sandro A. P. Haddad, 2009). In year 1958, a thoracic master at Karonlinska Hospital in Stockholm do embedded myocardial terminals and heartbeat generator with a rechargeable nickel-cadmium on 40 year old patient but the beat generator is fizzled inside of a few hours and function back on around 6 weeks.

In 1960, ten patients had profitable implantation because that year was introduce pacemakers which been developed. The batteries in pacemakers are basic in basic bit of the beat at terms of weight, volume and size. Immovable quality is fundamental segment for a heart pacemaker battery and for information batteries in implantable gadgets can't be supplanted. A decent battery configuration is a trade off between different and execution parameters to meet the prerequisites of the particular application

Parameter such as voltage, administration life, obligation cycle, time span of usability, temperature, time span of usability, well being and dependability, interior resistance, particular vitality (watt-hours/kg), particular force (watt/kg) and so on are understood. To pick a decent heart pacemaker is vital to chose the basic components, for example, least and most noteworthy voltage, starting, normal and most noteworthy release present, persistent or irregular operation (size and length of time of current heartbeats), long retire and administration life, particular force and high particular vitality, sway furthermore great execution in an assortment of conditions (temperature and obligation cycle). In unique difficulties being developed to cardiovascular pacemaker battery are bio compatible materials, lightweight and level sort, erosion and fixing, high unwavering quality and life battery. In beginning 1958, the early rechargeable (discretionary batteries) nickel-cadmium batteries was used of pacemaker add the function of human. The point of confinement was 190 mA hands the cell voltage was 1.25 V. The noteworthy issues have two; the first being short lifetime and the second was to put the commitment in regards to restoring in the hands of patients. The result is not recommending remedial practice.

Still some rechargeable pacemakers being used however not sold any more and that not have individual to redesign the method for improvement. The rechargeable battery simply made on nickel-cadmium but it not gives benefit. All things need take considered, voltages of battery pacemaker range in 2.5 V until 10 V. Around 1960s mercury-zinc batteries is given 4-8 V. Since 1970s, lithium batteries are suitable and helpful for pacemaker. In that lithium has the most critical element. The begun of lithium iodine battery in 1975 for supplanted the mercury-zinc battery is altogether enlarged the pacemaker battery life for more than 10 years for a couple models. The factor of lithium is reacts violently with water and an extensive variety of materials such as sulfur di-thionyl chloride, manganese dioxide besides carbon monofluoride is used for the dynamic cathode material. Then, Lithium has long life, little exhaust current and voltage traits

2.3 Wireless Power Transfer

Transmission of electrical power from fundamental power to devouring without utilizing strong wires or conductor is called the Wireless power transfer. (Yakovlev, Kim, & Poon, 2012). This is term that implies various diverse power transmission innovations that uses in time varying electromagnetic fields. Wireless transmission only used for power electrical devices when has interconnecting wires has been troublesome, dangerous or doubtful. On wireless power transfer has transmitter device which associated with power source. It means the main power line can transmits power by electromagnetic fields across at intervening space. Receiver devices has been converted back to electric power and utilized.

Has two type of techniques of wireless transfer is non-radiactive and radiactive. Techniques of Non-radiactive is magnetic fields can produce power and power can transferred over short separations utilized and inductive coupling between coils or devices by electric fields utilized a capacitive coupling between terminal or electrodes. Besides that, non- radioactive is suitable used for implant medical device like pacemakers. Power beaming is another name for radiactive. Radiactive use far-field technique. The techniques can transport energy longer distances, but must

aimed the receiver. Proposed application of radiative are power satellites and wireless powered drone aircraft. Moreover, wireless power transmission is a term was refers to a number of different technologies used for transmitting power by means of time-varying electromagnetic fields The process of transmitted like microwaves or laser beam. It can transfer energy long distance however must point at receiver. Table 2.1 is different wireless power technologies uses, differ in the distance over which they can transmit power efficiently, transmitter should be aimed (direct) at the receiver. Other than that, , in type of electromagnetic energy it's used; time varying electric fields, magnetic field, microwaves and radio waves, infrared or visible light waves. (Shinohara, Naoki 2014 and Tomar, Anuradha, Sunil July 2012).

Table 2.1: Different Wireless Power Technologies Uses

Innovation	**Distance**	**Frequencies (Hz)**	**Transmitted Devices**	**Future Applications**
Inductive	Shortest	Hz- MHz	Wire coils	Electric tooth brush and induction stovetops
Resonance	Shortest	MHz-GHz	Turned Wire coils and Element Resonator	Charging portable devices, *biomedical implants* and RFID
Capacitive	Middle	KHz-MHz	Electrodes	Large scale integrated circuits at power routing
Magneto dynamic	Shortest	Hz	Magnetic	Charging electric vehicles
Microwaves	Longest	GHz	Parabolic dishes, phased array,	Solar power satellite, power drone aircraft
Light Wave	Longest	≥THz	Laser	Powering drone aircraft