UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF MULTIPLE WIRELESS POWER TRANSFER SYSTEM

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Engineering Technology
(Bachelor's Degree in Electronic Engineering Technology) (Telecommunications with Hons.)

by

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DECLARATION

I hereby, declare this report entitled "Development of Multiple Wireless Power Transfer" is the 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 degree of Bachelor of Electronic Engineering Technology (Telecommunications) with Honours. The member of the supervisory is as follow:

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Supervisor's Name : SITI HALMA BINTI JOHARI

ABSTRAK

Projek ini bertujuan untuk membangunkan satu sistem yang mampu mengecas telefon bimbit menggunakan teknik induktif gandingan pemindahan kuasa. Perbezaan Wireless Power Transfer (WPT) teknik dan sistem kuasa tanpa wayar yang baru dicadangkan ini berupaya untuk menghantar kuasa secara tanpa wayar pada jarak yang lebih jauh kepada pelbagai jenis peranti dengan menggunakan peralatan elektronik sebagai komponen utama. Simulasi dan fabrikasi litar dibangunkan untuk menganalisis voltan antara 5 V – 12 V dan arus elektrik antara nilai 1 A -2 A dalam jarak antara 1 cm – 10 cm dimana medan elektromagnet telah terhasil melalui proses ini. Dengan menggunakan pemindahan kuasa tanpa wayar , ianya berupaya menghantar kuasa elektrik yang diperolehi dari sumber beban elektrik tanpa menggunakan wayar atau sumber kuasa, ia hanya menggunakan teknologi resonansi gandingan magnet untuk dijadikan pengecasan itu dengan menghantar arus yang mengubah fluks elektromagnet untuk dihubungkan menjadi medan elektrik dan menghasilkan arus elektrik . Industri ini perlu mengambil langkah inisiatif kerana permintaan menggunakan pengecas kuasa tanpa wayar perlu diwujudkan untuk memudahakn pengguna peranti mudah alih boleh menggunakan dengan lebih mudah tanpa menggunakan wayar .

ABSTRACT

This project purpose is to develop a system that was capable of charging a mobile phone using the resonant inductive coupling technique power transfer. These distances allow for use in small consumer electronic devices such as electric toothbrushes and razors. The difference in this Wireless Power Transfer (WPT) technique and the new proposed wireless power system is its ability to send power wirelessly over longer distances to multiple receiver of the wireless power transfer system using electronic equipment such as major components. The simulation and circuit fabrication are develop to analyze voltage between 5 V - 12 V and the current between 1 A – 2 A in distance between 1cm – 10cm where the electromagnetic field were produce upon this process. Multiple wireless power transfer is the transmission of electrical power that obtain from a source of an electrical load without using of conducting wires or materials ,it just use a magnetic resonance coupling technology to implement its charging by transmitting the current that converting electromagnetic flux to form an electric field to produce current. The industry realizes that demand of using a wireless power charging which is to create a mobile device that can be charged more easily without using a connecting wire.

DEDICATION

I would like to dedicate this thesis to my beloved mother, Siti Asiah bt Johar and my family members. There is no doubt in my mind that without their continued support and encouragement I could not have completed this thesis.

ACKNOWLEDGEMENT

First praise is to Allah, the Almighty, The Most Gracious and The Most Merciful the one whom always guiding us in our everyday life. I would like to express my appreciation to all whose guide me and provided me with possibility to complete my Projek Sarjana Muda 1. A special gratitude to my Project Supervisor Siti Halma Binti Johari, whose contribute in giving a guidance, suggestion and encouragement, helped me to align my project and writing the report. Furthermore I would also like to acknowledge and appreciate the staff and lab technician at Faculty Technology Engineering for the cooperation given and knowledge sharing. It has helped me a lot in developing my project. Last but not least, many thanks also go to my fellow friends in BETT class and others who involved directly and indirectly in completing this project.

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CHAPTER 1

INTRODUCTION

1.0 Introduction

Nowadays is a world of technological advancement .A new technologies has implement in worlds today .Each and every day a technology have been created which is to make our life more easier and faster. With all of these, humans still using on the classical and type of wire system to charge our devices everyday which is currently use low power devices such as mobile phones, digital camera .In addition using a wire have been mess up. It also takes up a lot of electric sockets and space which is its make more difficult to use for other electronic appliances. The idea solution to all these difficulty have been comes out, with using an inductive coupling concept, a simple and effective way of transferring power wireless have been created.

This chapter introduces overview and background of this project with the title "Multiple Wireless Power Transfer System". This project is using a resonant inductive coupling technique. One of the main purpose of this project is to compare different wireless power transfer against others WPT system.

1.1 Background Project

Wireless power transfer (WPT) is the transmission of electrical power that form a source called electromagnetic without using conducting wires or other electronic devices .To develop this project ,it have been divided into two parts ,first the transmitter circuit and secondly the receiver circuit which is the transmitter circuit is connected to the primary coil while the receiver circuit is connected to secondary coil .The power transmitter and receiver circuit will simulate and made into hardware .So in this project a voltage ,current ,power and distance will be analysed while during this project. To demonstrate the power was successfully transferred to wirelessly technique, a mobile phone is used to make it charged and there are multiple of loads that is used in this wireless power transfer systems.

Multiple wireless power transfer is the transmission of electrical power that obtain from a source of an electrical load without using of conducting wires or materials ,it just use a magnetic resonance coupling technology to implement its charging by transmitting the current that converting electromagnetic flux to form an electric field to produce current. The industry realizes that demand of using a wireless power charging which is to create a mobile device that can be charged more easily without using a connecting wire.

WPT devices have been suggested to be possible since Nikola Tesla's transmission model which established in 1897. The newest technologies have been designed on inductive coupling techniques to transmit power between transmitting and receiving coils. The most common and probably the oldest consumer application of wireless energy transfer can be found in the electric toothbrush. The size of the coils will be dependent on the how much power between receiver and transmitter will be delivered. Figure 1.1 show the simplified drawing of condition for wireless power transfer to mobile devices where primary components in any WPT system are the coils.

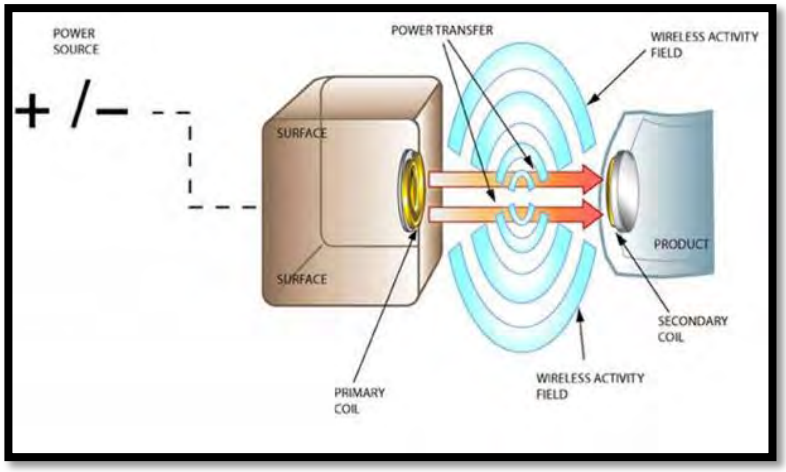


Figure 1.1: Simplified drawing of condition for wireless power transfer to mobile devices.

The system is divided into two part which is the transmitter circuit will provide power to the wireless transfer and the receiver circuit. Circuit that contains the primary coil will be transmitting the power through the power transmitter. To induce a magnetic field between the two coils a Dc to AC and series resonant capacitor inverter will be used to invert DC power to AC.A two halves of a resonant transformer will be produced through the primary and secondary coils. To demonstrate that power was successfully transferred wirelessly, a mobile phone was charged and there are multiple loads in wireless power transfer systems. The amount of power transmitted and effectively received will depend on how well the coils are designed.

The source drive which is a primary coil, will creates a magnetic field, which induces a voltage across the terminals of a secondary coil, and thus the power will transfer to a load. This mechanism, responsible to transfer the power in a transformer, where the magnetic field is typically is obtained which are happen between primary coils and secondary coils. To increase the voltage and power value that will be received to the device power, a parallel capacitor will be connected to the secondary part, which is its will be added up to form a resonant circuit at the operating frequency.

1.2 Problem Statement

Current wireless power transmitters of wireless power transfer (WPT) are usable to transmitting the source of current that convert electromagnetic flux to form an electric field. The difference in this WPT technique and the new concept of wireless power system is, it able to send power source as wireless with over longer distances to multiple receiver. This gives it an advantages gain value on the market.

A WPT that has been largely undiscovered is the ability to charge batteries and other electronic portable devices .In addition while wireless power devices have already been created by other companies and institute. They are still in basic trending and are not practically explored. A mobile user are not only feel disappointed when their battery is drain too fast or corrupt ,but they are also concern about the cost of electric bills that have been demand and high paid nowadays. There is some concern based on recently use of wireless power transfer techniques. Firstly, today most rechargeable or any portable electronic devices arrive with their own designed charger and cables. An average user that have been analysed in the world, it stated that each user of mobile electronic devices carries at least three of different chargers.

1.3 Objectives

The main objective of this project is to build a multiple wireless power transfer. In order to make this project successful, the objectives have been declared these objectives must be achieved in completing this project. Objectives are a guidance of any project, so the objectives have been listed below.

1. To study a system that was capable of charging a mobile phone using the resonant inductive coupling technique power transfer.
2. To develop a system of wireless power transfer for multiple small receivers**.**
3. To analyse wireless power transfer system over a longer distance

1.4 Scope of Project

The scopes of this project involved the development of the wireless power transfer system using the electronics equipment such as major components. In this project the simulation and circuit fabrication(hardware) are implement which is need to analyze ,the voltage that is use in this project is between 5V- 12V ,current between value 1A - 2A and distance between 1 cm – 10 cm. Thus an electromagnetic field will be create upon this. Before doing the circuit fabrication, a MULTISM software will be used to simulate whether the circuit is functioning or not. Thus after it is succeeded, a dot board will be used ,to design it whether it is functioning and finally a Proteus will be used, to design it as PCB.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

In this chapter, reviews of the previous researches project and existing literature that are related with this project will be discussed. The information will be become additional source for the project in becoming more successful. To have a brief understanding of the researches related to the project, a few literature reviews had been done. This chapter will describe the related literature reviews. It introduces the framework for the case study that comprises the main focus of the research described in this project. There are previous researches on resonant inductive coupling operation.

2.1 Summary of Previous Project

2.1.1 Optimal Operation of Contactless Transformers

In this paper, a boundary frequency is found for optimal operation of contactless transformers under different loading conditions that have found by (W.M. Ng, K.K. Lee and S.Y.R.). To improve it sustain energize, at the secondary side will be adding an external capacitor in series or in parallel with the secondary winding. The equivalent circuit of contactless transformer are shown in Figure 2.2(a).Primary coil and secondary coil circuit are used to present the inductance of primary winding and secondary winding, respectively. The capacitor will be added at the secondary side is Cs in Figure 2.2(b), which can be replaced in series or in parallel with the secondary winding. RL is stands for equivalent to the resistor of the load. Figure 2.1 shows the equivalent circuit of the primary side with reflected impedance from the secondary circuit called Z r.

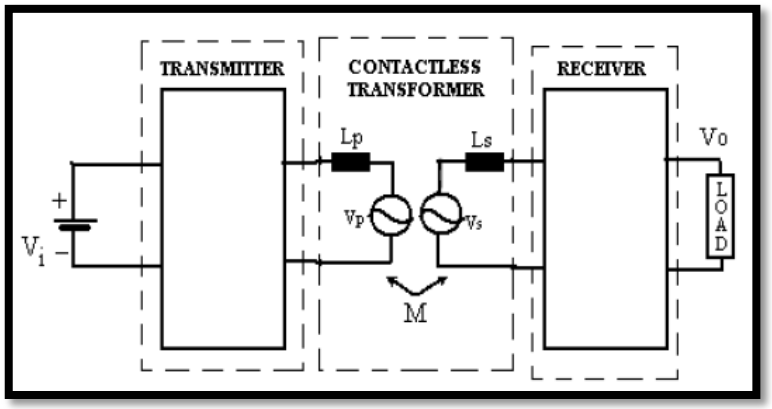
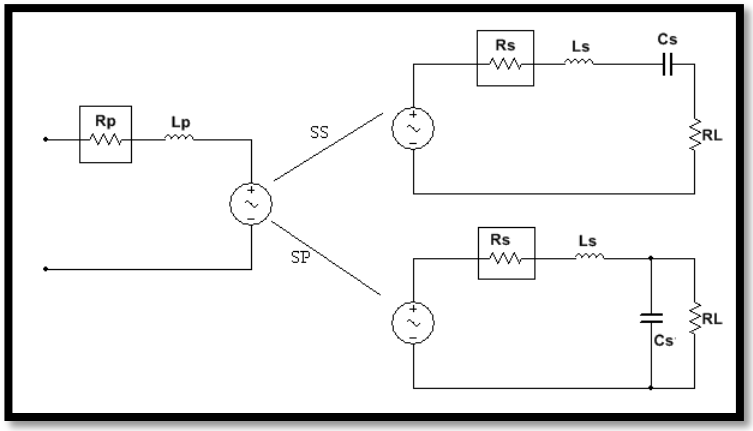
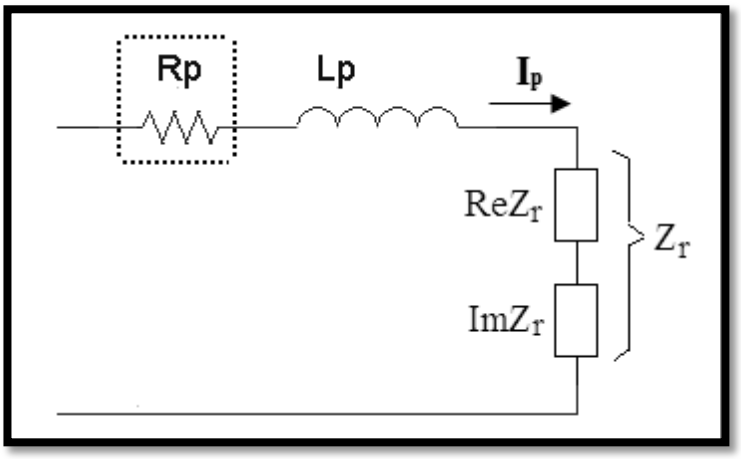


Figure 2.1: Block diagram of the contactless charging system



(a) Coupled model



(b) Primary side with reflected impedance

Figure 2.2: The equivalent circuit model of contactless transformer

2.1.2 Wireless power for mobile devices

A major part of this paper is to refers previous data from others publication on efficiency limits and cites from a further one, but new aspects about resonance operation and magnetic emissions are also added up that have been discovered by E.Waffenschmidt . In a further part of this work, an inductive power transmission pad is applied, which is it need to charge devices like mobile phones. Finally, the Wireless Power Consortium is discovered, which is it's recently released the first industry standard for inductive charging of mobile devices called "Qi", and have been reviewed in this paper. Figure 2.3 shows the input current (for a fixed voltage) at the part of transmitter coil shows a typical inductive power system, where the receiver comprises a series resonant capacitor.

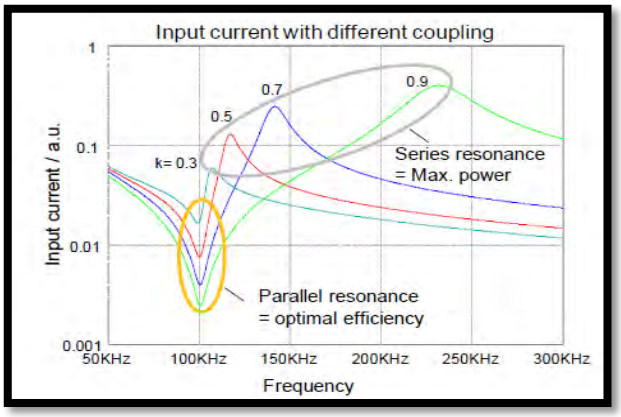


Figure 2.3: Input impedance spectra for different couplings showing two typical resonances.

Its shows that an input impedance spectrum that provide a different coupling of typical resonances transfer the power that is induced are not really stable because the efficiency is low. To maintain the energy wireless inductive power transfer, a transmitter and the receiver coils must be close apart so the power will be close due to the proximity that is happened each other.

2.1.3 Understanding Wireless Power

In this paper that have been discovered by David W.Baarman by a book that he write in 2009, he says that to develop a wireless power technology to consumers, its need to take more understanding of the different embodiments of wireless power technology, as well as clearly same definition as efficiency safety including pad and adapter solutions and a wireless power specification. Moreover, this paper discussed about mid-range technology. A mid-range wireless power is built around the idea by using resonant magnetic induction or near-field concept. The limitations to transmit the electromagnetic of this concept start with the diameter between the transmitter and receiver. In addition, an inductive coupled system can transmit charge between diameter of the transmitter and receiver. The figure 2.4 shows that mid-range or near-field functioning as a peak efficiency range that is fairly close to the proximity although it has extended range.

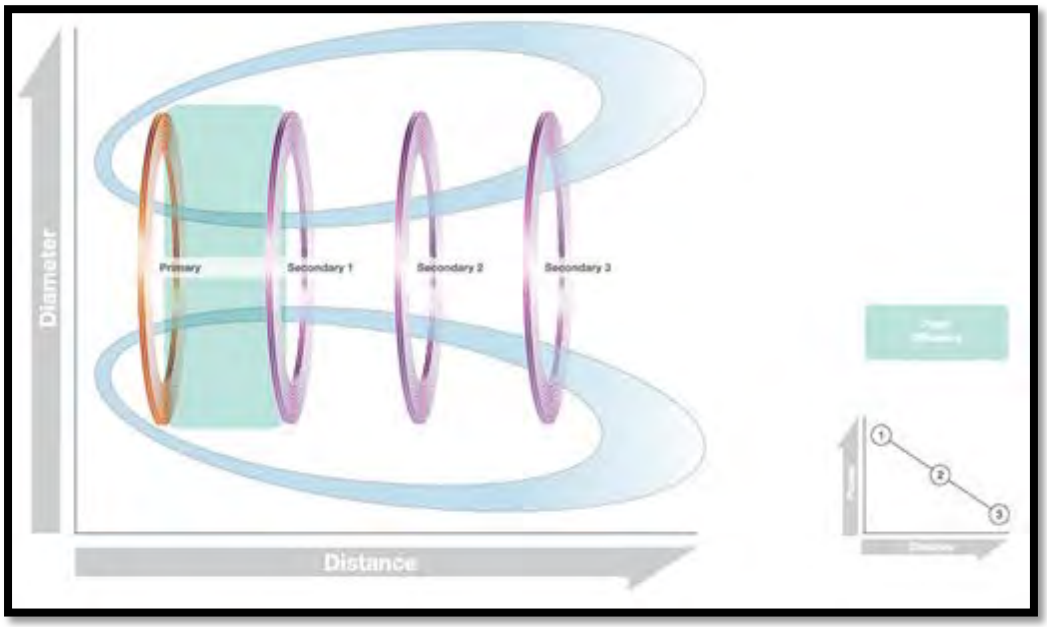


Figure 2.4 : Impacts coil to coil efficiency.

Although the mid-range is extended, the range of peak efficiency also will be extended in a smaller range. This happens when the initial commercialization technology is evolves. Large fields and higher frequencies will provide specific benefits which are the susceptibility issues will require further investigation and consideration.

2.2 Magnetic Field and Electric Current

A magnetic field is produce with all moving charged particles. A moving charge is known as electrons which produce magnetic field that depend on the charge, velocity, and acceleration of the particles. The direction of magnetic field is determined by using 'The Right Hand Rules'. The rule is used in two type of applications that use in a Ampere Law. Figure 2.5 shows a Right Hand Grip Rule.

i. An electric current passes through a solenoid, a magnetic field will occur. When someone wraps his/her right hand around the solenoid with their fingers, the direction of the conventional current will happens, the thumb points show the direction of the magnetic north pole.

ii. An electric current passes through a straight wire. Here, the thumb points in the direction will flow the current (from positive to negative), and there will be fingers point in the direction that show the magnetic lines of flux.

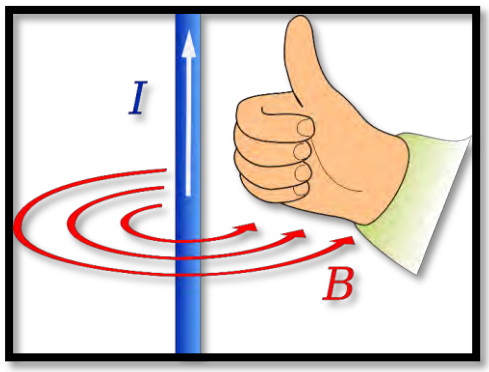


Figure 2.5: Right Hand Grip Rule.

The strength of the magnetic field will decrease if it distance is real apart from its wire. The magnetic field inside the loop will weaken the concentrates of the magnetic field if the wire is bending.

2.3 Nominal specifications for charging battery