

DESIGN AND DEVELOPMENT OF POWER INVERTER FOR INDUCTIVE  
POWER TRANSFER (IPT)

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**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**  
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 : FOR INDUCTIVE POWER TRANSFER (IPT)

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Dedicated to my beloved family especially my mother and to my friends who give me the encouragement and support to complete this project. Besides, millions of thanks to be given to my supervisor, Pn. Yusmarnita Binti Yusop and to my co-supervisor DR.Mohd Shakir Bin Md Saat who gave me lot of guidance throughtout this project.

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## ABSTRAK

Dalam dunia teknologi kini, Induktif Kuasa Pindahan ( IPT) system telah dicadangkan untuk mengecas peralatan elektrik secara wayarles atau tanpa sentuhan fizikal. Ini kerana tenaga elektrik boleh dihantar melalui ruang udara yang besar antara gegelung tanpa sambungan elektrik. Oleh yang demikian tiada masalah tercetus antara litar gegelung rendah dan menengah. Pada masa ini sistem IPT telah digunakan untuk menggantikan sistem konduktif sambungan fizikal seperti pengendalian bahan yang bergerak, dan pengecas bateri tanpa wayar, untuk menghasilkan kuasa untuk alih beban. Walau bagaimanapun, beberapa aplikasi pada masa kini memerlukan pemindahan kuasa tidak menghubungi untuk objek di mana sistem IPT rapat ditambah pula tidak boleh mencapai bergerak. Oleh itu, dalam projek ini sistem IPT digunakan untuk memindahkan kuasa seperti pengecas bateri. Idea yang terhasil kerana boleh menjana kuasa tanpa unsur-unsur konduktif seperti wayar dan soket di mana pasti ada ruang udara antara bahagian utama dan sekunder. Oleh itu, dalam projek ini satu kaedah dicadangkan untuk memindahkan kuasa di dalam IPT sistem. Rangkaian pemancar bekalan dalam projek ini adalah terhad menjana voltan 15V - 20V. Dalam projek ini, IPT sistem yang dicadangkan terdiri daripada mereka bentuk litar penukar boost, dan DC -AC penukar, kelajuan tinggi, pengayun dan penerus litar. Sistem IPT ini boleh dipercayai dan dijangka akan dibangunkan.

## ABSTRACT

In this high technology world, Inductive Power Transfer (IPT) system has recently been proposed to charging electrical devices wirelessly or without physical contact. This is because an electrical energy may be transmitted through a large air gap between coils without electrical connection. So that, no sparking effects due to contact problems between primary and secondary coil circuit. Currently IPT systems have been used to replace the conductive systems of physical connection such as materials handling, and contactless battery chargers of robots, for providing power to movable the loads. However, some applications nowadays require the non-contact power transfer for moving objects in which the closely coupled IPT systems cannot achieve. Hence, in this project the loosely coupled IPT system will be used to power up the battery charger. The development of IPT for battery charger consists of designing a transmitter and receiver circuit. The idea presented here because it can generate power without the conductive elements such as wire and socket. Therefore, in this project a loosely coupled method is proposed due to the possibilities of transferring power of IPT system. This is because it can transferred power wirelessly where must be some air gap between primary and secondary side. The range of the transmitter supply in this project is limited generate the voltage of 15V-20V by using boost converter. In this project, the development of the proposed IPT system consists of designing a Boost converter, and DC-AC converter, high speed, oscillator and rectifier circuit. A reliable and efficient IPT system is expected to be developed.



## TABLE OF CONTENTS

CHAPTER	CONTENT	PAGE
	<b>Title</b>	<b>i</b>
	<b>Report Verification Form</b>	<b>ii</b>
	<b>Student Verification Form</b>	<b>iii</b>
	<b>Supervisor Verification Form</b>	<b>iv</b>
	<b>Dedication</b>	<b>v</b>
	<b>Acknowledgement</b>	<b>vi</b>
	<b>Abstract</b>	<b>vii</b>
	<b>Abstrak</b>	<b>viii</b>
	<b>Table of Contents</b>	<b>ix</b>
	<b>List of Tables</b>	<b>xii</b>
	<b>List of Figures</b>	<b>xiii</b>
	<b>List of Abbreviations</b>	<b>xvii</b>
	<b>List of Appendices</b>	<b>xviii</b>
<b>I</b>	<b>INTRODUCTION</b>	<b>1</b>
	1.1 Introduction of Project	1
	1.2 Problem Statement	3
	1.3 Objectives	3
	1.4 Scope of Project	4
	1.5 Report Structure	5

<b>II</b>	<b>LITERATURE REVIEW</b>	<b>6</b>
2.1	Overview	6
2.2	IPT System	6
2.2.1	Basic Concept of IPT system	7
2.3	Boost Converter	8
2.3.1	The Operation of Boost Converter	8
2.4	Class E Inverter	11
2.4.1	The Operations of Class E Inverter	11
2.5	Full Wave Bridge Rectifier	13
2.5.1	Full Wave Bridge Rectifier Function & Operation	13
2.5.1.1	The Positive Half cycle	14
2.5.1.2	The Negative Half-cycle	15
2.6	Ripple Factor for Full-Wave Rectification	15
2.7	The Calculation of Multi Layer Air Core Inductor	16
2.8	Influence of Ferrite	17
2.8.1	Secondary side	18
<b>III</b>	<b>METHODOLOGY</b>	<b>19</b>
3.1	Introduction	19
3.2	The flow chart of methodology	20
3.3	The flowchart of the system	22
<b>IV</b>	<b>RESULT AND DISCUSION</b>	<b>25</b>
4.1	Introduction	25
4.2	Calculation Part	26
4.2.1	Calculation of Boost Converter	26

4.2.2	Calculation Class E Inverter	27
4.3	Simulation Part	28
4.3.1	Boost Converter Circuit	28
4.3.2	DC/AC Class E Inverter Circuit	31
4.3.3	High Speed Circuit	34
4.3.4	Rectifier Circuit	35
4.3.5	Number Turn of Coil	37
4.4	Measured Output Voltage by using difference turn of coil	38
4.4.1	10 turns of coil as primary and 30, 20, 10 turn coil as secondary	38
4.4.2	20 turn of coil as primary and 30, 20, 10 turn coil as secondary	40
4.4.3	30 turn of coil as primary and 30, 20, 10 turn coil as secondary	41
4.4.4	The Measurement of Current	42
4.4.5	The Measurement of Power	44
4.4.6	Measured Output Voltage and frequency from Oscilloscope	47
4.4.7	Analysis of output power and efficiency	59
<b>V</b>	<b>CONCLUSION AND RECOMMENDATION</b>	<b>62</b>
5.1	Introduction	62
5.2	Conclusion	62
5.3	Recommendation	63
	<b>REFERENCES</b>	<b>64</b>
	<b>APPENDIX A</b>	<b>66</b>
	<b>APPENDIX B</b>	<b>68</b>

## LIST OF TABLES

NO	TITLE	PAGE
Table 4.1	Operation of the converter	32
Table 4.2	Number of turn that measured	38
Table 4.3	10 turns of coil as primary and 30, 20, 10 turn coil as secondary	38
Table 4.4	20 turns of coil as primary and 30, 20, 10 turns coil as secondary	40
Table 4.5	30 turns of coil as primary and 30, 20, 10 turn coil as secondary	41
Table 4.6	The current measured by adjusting the distance between coils	42
Table 4.7	The power measured by adjusting the distance between coils 10(p)-30(s)	44
Table 4.8	The power measured by adjusting the distance between coils 10(p)-20(s)	45
Table 4.9	The power measured by adjusting the distance between coils 10(p)-10(s)	46
Table 4.10	The power losses and efficiency measured by adjusting the distance between coils 10(p)-30(s)	59
Table 4.11	The power losses and efficiency measured by adjusting the distance between coils 10(p)-20(s)	60
Table 4.12	The power losses and efficiency measured by adjusting the distance between coils 10(p)-10(s)	61

## LIST OF FIGURES

NO	TITLE	PAGE
Figure 1.1	Process of Wireless Power Transfer	2
Figure 1.2	The block diagram of the project	4
Figure 2.1	The process of Ampere and Faraday Law	7
Figure 2.2	The equivalent circuit of boost converter	9
Figure 2.3	When the switch of boost is open	9
Figure 2.4	When the switch of boost is closed	10
Figure 2.5	The circuit of MOSFET Class E Amplifier	11
Figure 2.6	The ideal waveforms for 100% of efficiency for voltage and current	12
Figure 2.7	The schematic of diode bridge rectifier circuit	13
Figure 2.8	The current flow in Bridge Rectifier for Positive Half cycle	14
Figure 2.9	The current flow in Bridge Rectifier for Negative Half Cycle	15
Figure 2.10	The calculation of multi layer air core inductor	16
Figure 2.11	Magnetic flux in coils without core	17
Figure 2.12	Magnetic flux in coils using a ferrite core	17
Figure 2.13	Coupling coefficient VS Air gap for coils with ferrite core and coils in the air	18
Figure 3.1	Flow chart of overall methodology	20
Figure 3.2	The flowchart of the system	22
Figure 4.1	The overall project of IPT system	25
Figure 4.2	The simulation of boost converter circuit by using	28

	Itspice software	
Figure 4.3	The boost converter results in theoretical by using Itspice software	28
Figure 4.4	The simulation of boost circuit on the breadboard	29
Figure 4.5	The Boost converter result in practical by using oscilloscope	29
Figure 4.6	Boost circuit by using Proteus software	30
Figure 4.7	The simulation of Class E Inverter circuit by using Itspice software	31
Figure 4.8	The Class E Inverter results in theoretical by using Itspice software	31
Figure 4.9	The simulation of Class E Inverter circuit on the breadboard	32
Figure 4.10	The Output waveform of Class E Inverter in practical by using oscilloscope	32
Figure 4.11	DC/AC system output square wave	33
Figure 4.12	Zero Voltage Switching of Class E Inverter Circuit by using oscilloscope	33
Figure 4.13	Class E inverter by using Proteus software	33
Figure 4.14	The simulation of High Speed circuit on the breadboard	34
Figure 4.15	The combination of high speed and oscillator circuit by using Proteus software	35
Figure 4.16	Scheme of the secondary side by using Multisim Software	35
Figure 4.17	The simulation of Rectifier circuit on the breadboard	36
Figure 4.18	The result of rectifier waveform in theoretical by using multisim	36
Figure 4.19	Rectifier circuit by using Proteus	36
Figure 4.20	The number of coil is 30 turns	37
Figure 4.21	The number of coil is 20 turns	37
Figure 4.22	The number of coil is 10 turns	37
Figure 4.23	Graph for output voltage when the primary is 10 numbers of turns and the secondary is 30, 20 and 10 numbers of turns	39
Figure 4.24	Graph for output voltage when the primary is 20 numbers of turns and the secondary is 30, 20 and 10 numbers of turns	40
Figure 4.25	Graph for output voltage when the primary is 30 numbers of turns	41

	and the secondary is 30, 20 and 10 numbers of turns	
Figure 4.26	Graph for output current when the primary by adjusting the distance between coil	43
Figure 4.27	Graph for output power when the primary is 10 numbers of turn and the secondary is 30 numbers of turns	44
Figure 4.28	Graph for output power when the primary is 10 numbers of turns and the secondary is 20 numbers of turns	45
Figure 4.29	Graph for output power when the primary is 10 numbers of turns and the secondary is 10 numbers of turns	46
Figure 4.30	The measurement when the distance between coils is 4.0cm	47
Figure 4.31	The measurement when the distance between coils is 3.5cm	47
Figure 4.32	The measurement when the distance between coils is 3.0cm	47
Figure 4.33	The measurement when the distance between coils is 2.5cm	48
Figure 4.34	The measurement when the distance between coils is 2.0cm	48
Figure 4.35	The measurement when the distance between coils is 1.5cm	48
Figure 4.36	The measurement when the distance between coils is 1.0cm	49
Figure 4.37	The measurement when the distance between coils is 0.5cm	49
Figure 4.38	The measurement when the distance between coils is 0cm	49
Figure 4.39	The measurement when the primary coil is 10turn and secondary is 30 turns.	50
Figure 4.40	The measurement when the distance between coils is 4cm	51
Figure 4.41	The measurement when the distance between coils is 3.5cm	51
Figure 4.42	The measurement when the distance between coils is 3.0cm	51
Figure 4.43	The measurement when the distance between coils is 2.5cm	52
Figure 4.44	The measurement when the distance between coils is 2.0cm	52
Figure 4.45	The measurement when the distance between coils is 1.5cm	52
Figure 4.46	The measurement when the distance between coils is 1.0cm	53
Figure 4.47	The measurement when the distance between coils is 0.5cm	53
Figure 4.48	The measurement when the distance between coils is 0cm	53
Figure 4.49	The measurement when the primary coil is 10turn and secondary is 20 turns.	54

Figure 4.50	The measurement when the distance between coils is 4cm	55
Figure 4.51	The measurement when the distance between coils is 3.5cm	55
Figure 4.52	The measurement when the distance between coils is 3.0cm	55
Figure 4.53	The measurement when the distance between coils is 2.5cm	56
Figure 4.54	The measurement when the distance between coils is 2.0cm	56
Figure 4.55	The measurement when the distance between coils is 1.5cm	56
Figure 4.56	The measurement when the distance between coils is 1.0cm	57
Figure 4.57	The measurement when the distance between coils is 0.5cm	57
Figure 4.58	The measurement when the distance between coils is 0cm	57
Figure 4.59	The measurement when the primary coil is 10turn and secondary is 10 turns	58



## LIST OF ABBREVIATIONS

IPT	-	Inductive Power Transfer
CPT	-	Capacitive Power Transfer
WPT	-	Wireless Power Transfer
FWR	-	Full Wave Rectifier
HWR	-	Half Wave Rectifier
FYP	-	Final Year Project
P	-	Primary
S	-	Secondary

**LIST OF APPENDICES**

<b>NO</b>	<b>TITLE</b>	<b>PAGE</b>
A	DATA SHEET OF MOSFET IRF 530	67
B	DATA SHEET OF MOSFET IRF 510	69

## CHAPTER 1

### INTRODUCTION

#### 1.1 Introduction of Project

Nowadays, many electronic devices are invented. Such devices are described in Practical Electronic books, Project Books and over the Internet. These gadgets help make our lives easier. Many people now are using them in their fields of study or projects. Electronic devices ease and simplify everything that already done. This chapter will discuss briefly about the project introduction that consist of problems statement, objectives, scopes and methodology of the project.

In this high technology world, the advanced technology has generally variety of portable electronic devices. The mobile phone, gadget and laptop are the examples of the growth technology. However, users still needed to plug in these devices manually when the battery used is the lower charger. As for this current issue the wireless power transfer (WPT) is proposed to identify the possibility of connector battery wirelessly.

WPT are usually applied for high power electronic applications and now it invented as self powered electronic systems and enhances the overall efficiency and reliability of the system. WPT has quickly changed as significantly change our life with environmental friendly and green technology. In this case, WPT is the process where the electrical energy is transmitted from a power source to an electrical load

across an air gap using induction coils. There are various types of WPT technologies which are Capacitive Power Transfer (CPT), Induction Power Transfer (IPT), light and etc. In this project, the IPT system has been proposed [12].

This IPT system is based on the fundamental of Faraday and Ampere law. This is function of alternating magnetic fields to transfer power from a primary winding to a secondary winding. Other than that, in order to protect and preserve the world natural resources the power source can be replaced with the solar source. Usually energy that has been produced is everywhere and anywhere in the surrounding, which is solar energy are categorized as natural energy sources where it used in high power application such as actuate a solar panel car, factory and etc. The illustration of process of WPT is shown in Figure 1.1.

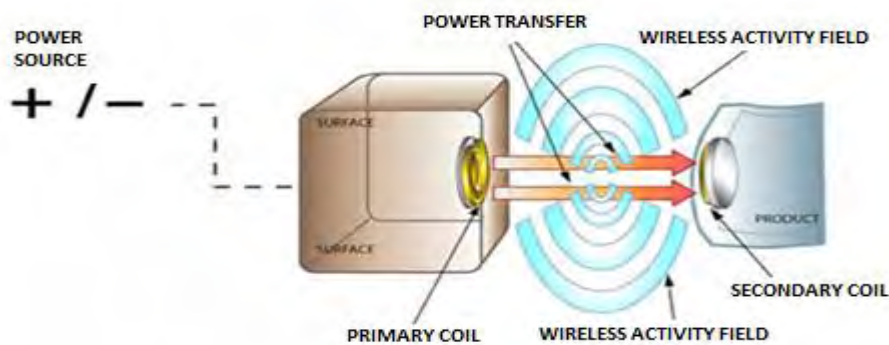


Figure 1.1: Process of Wireless Power Transfer

For another example, this power transfer can be direct wireless power interconnections and automatic wireless charging for mobile phones, household robots, mp3 players, laptop computers and other portable electronics wire-free. Since wireless power transfer is really famous among many researchers, the various inventions and applications that related to wireless power transfer are created to apply the theoretical. For example, the handheld electronic devices using Inductive power transfers devices, remote wireless sensors using solar panel or RF energy from antenna, remote wireless actuators using thermal energy and others have been created for high power transfer and more efficiency.

## 1.2 Problem Statement

In case of domestic wiring, there are using the cables to powering up the wiring. By this way, it is requiring complex wiring system that can cause short circuit and difficult for troubleshooting if any problems happen. For example of home use especially for DC supply such as table lamp, charging mobile phone, gadget and etc.

Usage rate of electric energy because of number of electrical equipment is overload and not appropriate for single phase user .The effective power transfer is very important because the secondary coil is the types of material determine the amount of power transferred. In that case the power supply is of special concern. This is because in a number of cases where batteries are used, the energy content is too low and batteries have a limited life time.

Since the energy yield will be too low for various applications even if energy scavenging techniques exists, IPT could be used to solve these problems. The idea presented here because it can generate power without the conductive elements such as wire and socket. By using this IPT system, all weaknesses can be improved.

## 1.3 Objectives

The main objective of this final year project is as an alternative for students to show their knowledge, skills and ideas to produce a product that is related to electronic engineering. The project is completed by following the instructions and project progress specifications. There are some objectives of this final year project that need to be achieved due to the following aspects below:

1. To design DC-DC boost converter for IPT system
2. To design DC-AC converter with class E power amplifier for IPT system
3. To analyze the performance of power converter developed in terms of output power and efficiency

## 1.4 Scope of project

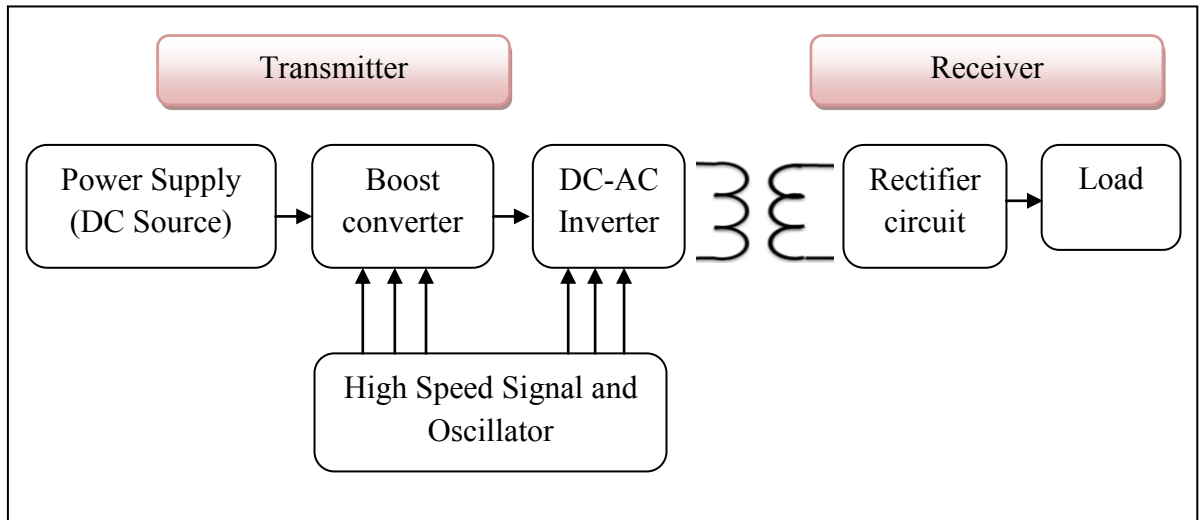


Figure 1.2: The block diagram of the project

By referring the Figure 1.2, it shows the block diagram of the project. In this project, the IPT system for charger will be developed where the system consists of designing the transmitter and receiver circuit. In this project, the power can be transferred from transmitter to receiver with an air gap of 0.5cm to 3.5cm. Since there are many issues about inductive power transfer device, so, this project just focuses on the following properties below:

- i. Primary supply - DC power supply or solar panel will generate the voltage direct current 7V-9V. Then the power supply will be connected to the boost converters which have increased the voltage direct current around 15V to 20V. The MOSFET that is used is IRF510 and it is driven by high speed and oscillator that will produce 1MHz of frequency.
- ii. The development of inverter is by using class E power amplifier. The MOSFET that is used is IRF530 and it must produce 50% duty cycle of frequency. The MOSFET is driven by high speed and oscillator that will produce 1MHz of frequency. The simulation is used for analysis of the expected result and to control the signal for inverter circuit.

- iii. The number turns of coil is identifying to transmit power from primary coil to secondary coil.
- iv. For the secondary part is the output part. The output is connected to the rectifier circuit to produce the output of the project. The output in this project is in Direct Current (DC).

## 1.5 Report Structure

In order to complete this thesis, 5 requirements need to be completed, which are Introduction, Literature Review, Methodology, Result and Discussion, and the last chapter is a Conclusion and Further Development of the project. In chapter 1, the project overview such as introduction, problem statement, objectives, and the scope of IPT system are discussed. Through this chapter 2, the literature reviews on the systems background are discussed. The literature review is about the WPT system, boost converter, class e inverter, rectifier circuit and the IPT system that involve in this project. In addition, brief review on the concept and theory related to the problem and development of the wireless system that needed for development of the whole project. For chapter 3, it is about the methodology for development of the electronic structure. The algorithm and procedure of designing the IPT system is clearly explain the procedures with some figures and flow charts. The next chapter is chapter 4, the results obtained for the whole project. The results can be divided into two parts which are simulation and experimental results. All results of designing the circuit are clearly presented by tables and figures. The discussion concentrates on the results and performance of the charging system. The discussion is valuable for future development of the charging system. Lastly, in chapter 5, a summary of the project of the IPT system for charging system is presented. The recommendations and modifications required for this project lead to further research.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Overview

This chapter contains of the literature review on past research and the theoretical concepts applied in this project. It contains the collection information of the project in order to complete the whole project. The literature will focus on the comparison between few paper of journal that are focus on the advantages and disadvantages, efficiency and the application of developing in this IPT systems.

#### 2.2 IPT System

##### 2.2.1 Basic Concept of IPT System

IPT system is a technique of transferring power wirelessly over a short distance in the range of 1cm to 30cm [5]. The technique of transferring power is derives its capability from the two fundamental electromagnetism revealed by Ampere's law and Faraday's law. The function of IPT systems is based on the changing magnetic field that is created due to alternating currents through a primary coil that induce a voltage onto a secondary coil by means of air. The process of transferring power is shown in Figure 2.1.