CONVERSION OF MICROWAVE TO DC BY USING RECTENNA

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Tajuk Projek : **CONVERSION OF MICROWAVE TO DC BY USING RECTENNA**

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Author : ENGR. NAJMIAH RADIAH BINTI MOHAMAD

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Dedicated to my parents, my siblings and also my colleagues and friends who had been supporting me through thick and thin.

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ABSTRACT

Power sources such as battery nowadays have become part of the human life. The battery always been the problem where it lifetime is short. Even though nowadays, with invention of energy harvesting scattered around the world at all market, the short lifetime of the source still a main problem. All this energy harvesting irrespective of their manufacturer and batteries has the limited power sources which either need recharging or replace with a new one. Proposal of the project application is to converting the microwave signal to DC voltage. This is done by use of microwave signal which is the microwave signal is transmitted from the transmitter signal using antenna at a frequency 2.45 GHz. Rectenna is the combination of rectifying circuit and antenna. The project material that will be use is FR4 board for antenna design. RF schootky diode will be used to construct rectifying circuit. The matching of the schootky diode will be in stub matching form which will be design on FR4 board. The horn antenna is used as transmitter that transmits power at 2dBm to 20dBm. The rectenna then will be used to convert microwave signal into DC voltage. For 15cm distance, the higher voltage produce is 0.8V which is quite high and can power up small electronic device such as USB and LED. The lowest voltage produce is 0.001V.

ABSTRAK

Sumber kuasa seperti bateri sekarang telah menjadi sebahagian daripada kehidupan manusia. Bateri sentiasa menjadi masalah di mana ia mempunyai hayat yang pendek. Walaupun pada masa kini, dengan penciptaan penuai tenaga yang berkembang di seluruh dunia pada semua pasaran, jangka hayat yang pendek sumber masih lagi menjadi masalah utama. Tenaga penuaian tanpa mempunyai sumber kuasa yang terhad samada perlu mengecas semula atau menggantikan dengan yang baru.Proposal baru permohonan projek adalah untuk menukar isyarat gelombang mikro voltan DC. Ini dilakukan dengan menggunakan isyarat gelombang mikro dimana isyarat gelombang mikro dipancarkan dari isyarat pemancar menggunakan antena pada frekuensi GHz 2,45. *Rectenna* adalah gabungan litar penerus dan antena. Bahan projek yang akan digunakan adalah papan FR4 bagi reka bentuk antena. RF diod schootky akan digunakan untuk membina litar penerus. Pemadanan diod schootky akan berada dalam bentuk pemadanan *stub* yang akan menjadi reka bentuk pada FR4 lembaga. Antena *Horn* digunakan sebagai pemancar yang menghantar kuasa sebanyak 2dBm kepada 20dBm. *Rectenna* kemudiannya akan digunakan untuk menukar isyarat gelombang mikro kepada voltan DC. Untuk jarak 15cm, voltan yang dikeluarkan paling tinggi adalah 0.8V dan boleh menjana peranti elektronik kecil seperti USB dan LED. Hasil voltan yang paling rendah adalah 0.001V.

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LIST OF ABBREVIATIONS

AC	-Alternating Current
DC	-Direct Current
FR4	-Flame Retardant 4
LHC	-Left-Handed Circular
PCB	-Printed Circuit Board
RHC	-Right-Handed Circular
RF	-Radio Frequency
SPT	-Space Solar Power Transmission
UV	-Ultra Violet
WPT	-Microwave Wireless Power Transmission

CHAPTER I

INTRODUCTION

This chapter will include the overview of the project which is project background, project objective, project scope, project methodology, and summarization of the project

1.1 Project Introduction

Nowadays, there are many items which can use as a source including microwave. In Malaysia, most urban area has microwave such as WLAN using by people for surfing internet. The microwave from this WLAN can be used to convert it into energy.

The application of project is to convert microwave signal to DC (Direct Current) power by Using Rectenna. It can be done using microwave signal which is transmitted from the transmitter along with the message signal using antenna at a frequency 2.45 GHz.

Using the ISM Band which is 2.45 GHz will give a lot advantages to the rectenna. Using the microwave with the application to convert microwave signal into DC voltage will provides great advantages.

Rectenna with DC power conversion could provide a new revelation for power source technology.

1.2 Project Objectives

Objectives of the project are to design and study rectenna with good matching, filter and rectifying circuit via wireless connection through S-Band microwave at 2.45 Ghz, then to simulate and fabricate the circuit of the project.

The antenna will capture the microwave signal which is at 2.45 GHz. The antenna with the filter will remove the unrequired frequency. The energy converted which is AC (Alternate Current) will then be converted into DC current through rectifying circuit. The rectifying circuit consists of schootky diode that has the very low drop voltage and specially made for the microwave field.

At the final stage, the project is expected to convert DC power through the power of microwave and then to make sure that the expected power provide is sufficient enough for replacing source such as battery.

1.3 Problem Statement

H.Takhedmit and et al, state efficiency of the rectifier is altered by the losses of both diodes and impedance mismatching, which mean diode losses usually being dominant at overall case. In addition, the efficiency of the receiving antenna affects the overall efficiency of the rectenna. [10]

Besides that, Zied Harouni and et al, state that the rectenna with integrated circular sector antenna can eliminate the need for a low pass filter (LPF) placed between the antenna and the diode as well as produce higher output power. [11]

From the other findings, Fang Zhang and et al, state that it is shown that using this folded dipole structure, the traditional rectenna system design can be almost simplified to only a required antenna design. [12]

Lastly, from my own finding after tested my design rectenna. I found out that the ambient frequency is not having sufficient power to produce high output DC voltage. The transmit power will be sufficient when generate it using RF signal generator.

1.4 Project Scope

Figure 1.1 shows the overall project scope of this thesis. The project scope is to research and study about microwave power transfer wirelessly. A transmitter which is horn antenna will be connected via radio frequency cable.

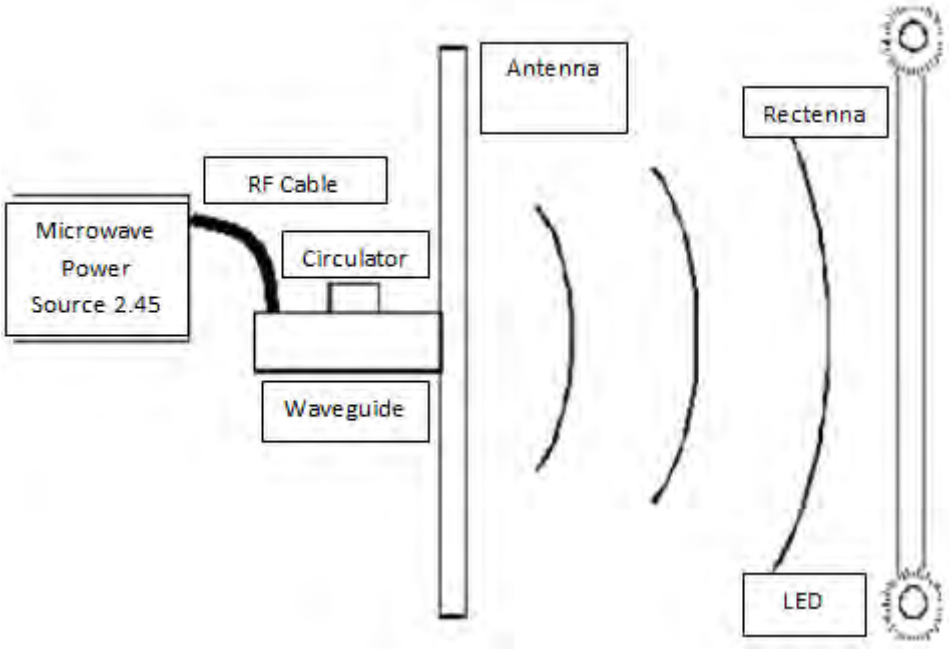

Figure 1.1 Block Diagram of overall project

Microwave power source is used to generate microwave signal which will transfer transmitted microwave using RF cable to antenna. The antenna generally will transmitted microwave signal to surrounding in ISM Band which is 2.45 Ghz

The microwave signal will then be converted into DC power by rectenna. Rectenna which contains antenna, filter, schottky diode and load will then trigger, and then the converted power is expected to produce medium voltage which can replace battery source.

1.5 Methodology

The proposals of the project make, then the study and research about the project done from reviewing the book, journal, discussion, and other sources. At early stage, the project is focus on transmitter design which is needed to generate 2.45 Ghz frequency. After reviewing journals, slotted wave guide antenna is the suitable one to transmit the microwave signals.

For the receiver part, designing the antenna is required. Using software called CST Microwave Studio can design the desired antenna which will operate at 2.45 Ghz frequency. Filter should be able to block higher harmonic frequency and match with antenna. Matching circuit can be done using Advanced Design System software.

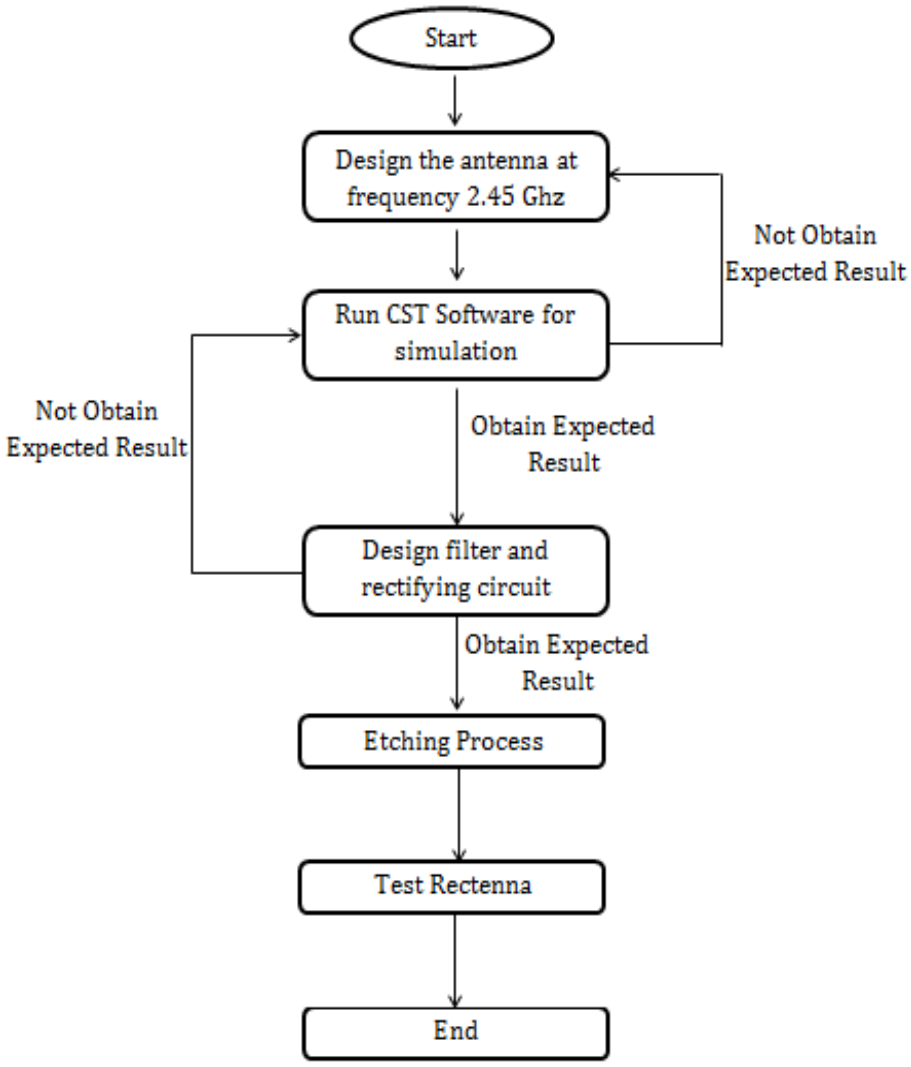

Figure 1.2 Flow Chart for the Rectenna Project

1.6 Thesis Outline

This report contains five chapters that will explain detail about the project of designing microwave wireless charger in application for charging mobile phones.

First chapter is introduction of the project. This chapter will include the overview of the project which is project background, project objective, project scope, project methodology, and summarization of the project.

Second chapter is about literature review which will discuss the finding and research about the project

Third chapter is about theoretical background of project. This chapter will discuss about the fact and information obtains from many sources required to precede the project. The component and any other material will be discussed in this chapter.

The fourth chapter contains methodology of the project. The methods and technique that will be used in the project will be discussed. The detail and information about the component will be given.

Fifth chapter is about result and discussion. This section will explain about the finding of the project, the analysis of result. Method used to analyze result will be explains.

Last chapter in the report will be conclusion and recommendation which will include overall of the project and will suggest improvement about the project.

CHAPTER II

LITERATURE REVIEW

This chapter will discuss about the finding and research about the project

The rectenna is the combination of rectifying circuit and antenna which will convert the microwave signal into DC voltage.

The growing proliferation of wireless communication devices raises the issue of their energy autonomy. The dc powering of abandoned sensors or sensor nodes localized in areas which are dangerous or difficult to reach are a sample of application. Wireless energy transmission is then an alternative method to avoid conventional power source imbedded inside the structure. In this study, we focused on the microwave conversion at 2.45 GHz, frequency greatly used due to its low attenuation through the atmosphere, low cost technology and location at the center of un-licensed ISM (Industrial-Scientific-Medical) frequency band [1].

The rectenna is an important device to convert RF power into dc power. It contains an antenna which collects microwave incident power and a rectifying circuit. The rectifier has a nonlinear characteristic and converts RF power into useful dc power.

A rectifier is often made up of a combination of Schottky diodes, an input HF filter, an output bypass capacitor and a resistive load. Usually, the input HF filter is a low pass filter (LPF) which rejects harmonics created by the diode. It also acts as a matching circuit between the antenna and the rectifying circuit [2]. This low pass filter can be directly included on the radiating element by using harmonic-rejecting antennas [4].

Besides, rectifying antenna (rectenna) which can convert RF energy to DC power plays an important role in free space wireless power transmission (WPT). Over the last century, the development of rectenna for space solar power transmission (SSPT) [1] as well as WPT [2] had great achievement with specific functions; and the applications e.g., actuator [3] or wireless sensors [4].

The typical rectenna in the prior literatures [7] basically consists of four elements: antenna, low pass filter (LPF), diodes, and DC pass capacitor. The initial development of rectenna focuses on its directivity and efficiency for great power reception and conversion, hence, large array [8] was usually adopted for microwave power reception. Afterward, many functions were added to enhance the performance of the rectenna array, such as arbitrary polarization [9], dual-polarization [10], CP [11], and dual band [12]. Besides, for the antenna integrated with nonlinear circuits, such as diodes and FETs, it is well known that harmonics of the fundamental frequency would be generated. The unwanted harmonics cause problems of harmonics re-radiation and efficiency reduction of rectenna; then the LPF is required to suppress harmonics to improve system performance and prevent harmonics interference. For size reduction and cost down, the antenna with harmonic rejection property was proposed to eliminate LPF [13].

Future research will be able to design a better rectenna for DC voltage converting and can be used in many applications.