A DESIGN OF AN AIR IONIZER USING THE COCKCROFT – WALTON VOLTAGE MULTIPLIER

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This report is submitted in partial fulfillment of requirements for the award of Bachelor of Electronic Engineering (Industrial Electronics) With Honours

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Special dedicated to my beloved parent, family, lecturer, friends, who had strongly encouraged and supported me in my entire journey of learning.

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ABSTRACT

Air Ionizer is a project that required design by using the Cockcroft-Walton Voltage Multiplier to generate negative ion. The air ionizer will produced negative ions in the air for a small room such as the tutorial room in FKEKK. This project will develop an air ionizer which can produce the negative ions to the air. The development of the air ionizer will involve electronic circuit. The Cockcroft-Walton design is based on the Half-Wave Series Multiplier. By using only capacitor and diodes, these voltage multipliers can step up relatively low voltage to extremely high value. This project will focus on the generation of a massive amount of negative ions. The advantages of this project will using a low cost component and easy to insulate. The problem statements are the quality of air is reducing and causing many health problems to mankind. Beside that, now there is green house effect that will cause the damage to a human such as skin effect, asthma and other illness related to the air. This circuit is design to solve the problem related to the low quality air in a small room. The main objectives of this project are to generate negative ions by exposing air to a high negative voltage and to converts AC or pulsing DC electrical power from a low voltage level to a higher DC voltage level. Through this project, the characteristic of the Cockcroft-Walton Multiplier circuit will discussed and the related circuit will be design and simulated.

ABSTRAK

Projek ini dibuat bagi mereka satu litar yang boleh digunakan untuk menghasilkan ion negative didalam udara dengan menggunakan pendarab voltan Cockcroft-Walton. Pengion negative ini akan digunakan bagi menghasilkan ion negative untuk kawasan yang kecil seperti bilik tutorial di FKEKK. Pengion yang direka ini akan menghasilkan ion negative di dalam udara. Projek ini memerlukan rekaan dan binaan litar elektronik keseluruhannya. Dengan hanya menggunakan capacitor dan diod akan menaikkan voltan yang rendah kepada voltan yang tinggi. Kebaikan projek ini adalah ianya menelan belanja yang murah bagi kos komponen dan mudah untuk di reka. Pengion ini direka berdasarkan teori Cockcroff-Walton yang membuktikan bahawa ion negative dapat dipisahkan daripada udara sekiranya voltan yang tinggi dialirkan pada satu konduktor pada udara. Pengion negative ini penting bagi mengurangkan ion-ion positif dalam udara yang mana sekiranya terlalu banyak ion akan memberi kesan negative kepada kesihatan manusia. Pernyataan masalah bagi projek ini adalah kualiti udara yang semakin berkurang dan kesan rumah hijau yang akan mendatangkan kemudaratan kepada manusia seperti masalah kulit, lelah dan lain-lain penyakit. Objektif utama projek ini adalah untuk mereka satu litar pengion yang dapat menghasilkan ion-ion negative dalam udara yang dapat mendedahkan udara kepada negative voltan yang tinggi berdasarkan teori Cockcroft-Walton. Melalui projek ini, ciri-ciri pengganda Cockcroft-Walton dapat dikenalpasti dan dibincangkan manakala litar yang terlibat akan dibuat simulasi bagi memperoleh voltage keluar yang memenuhi syarat teori tersebut.

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CW	-	Cockcroft – Walton
FKEKK	-	Fakulti Kejuruteraan Elektonik dan Kejuruteraan Komputer

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CHAPTER 1

INTRODUCTION

This chapter is about to brief introduction of the ‘ Projek Sarjana Muda (PSM) thesis. This thesis will introduce what the whole project is all about. The project is to design an air ionizer using the Cockcroft-Walton Multiplier. Chapter 1 is about the introduction of the project, the objective of the project, problem statement, scope of project and simple explanation of methodology. It will give the overview on about this project.

1.1 INTRODUCTION OF THE PROJECT

This project is about design of an Air Ionizer by using Cockcoft-Walton Voltage Multiplier is to generate negative ions by exposing air to a high negative voltage. This circuit is design to solve the problem related to the low quality air in a small room. The ionizer will produce negatives ions and neutralize the ions in the air.

The negative ions work by producing the negative output which exceeding 5kV at the end of the Cockcroft-Walton Voltage Multiplier circuit. The Cockcroft-Walton circuit is one of the cheaper ways of generating high voltage at relatively low current is

the classic multistage diode/capacitor voltage multiplier. By using only capacitors and diodes, these voltage multipliers can step up relatively low voltages to extremely high values. The Cockcroft-Walton is design based on the Half-Wave Series Multiplier, or voltage doublers. The biggest advantage of such circuit is that the voltage across each stage of this cascade is only equal to twice the peak input voltage.

The development of the air ionizer will involve mechanical and electronic circuit. An air ionizer is a device which used high voltage to ionize, or electrically, air molecules. Ionizers create ions by either adding electrons to atoms/molecules or stripping electrons from atoms/molecules. The basic part of this project is to generating high voltage from a low voltage AC. This project will focus on the generation of a massive amount of negative ions.

1.2 OBJECTIVES OF PROJECT

The objectives of this project are:

1. To converts AC or pulsing DC electrical power from a low voltage level to a higher DC voltage level.
2. To generate negatives ions by exposing air to a high voltage.
3. To solve the problem related to the low quality of air in a small area such as a lecture room.

The first objective is to converts AC or pulsing DC electrical power from a low voltage level to a higher DC voltage level. To achieve the objective, this project is used some basic electronic knowledge and Cockcroft Walton theories to design an air ionizer which will produce negative ion. The Cockcroft Walton is basically a voltage multiplier that converts AC or pulsing DC electrical power from a low voltage level to a higher

DC voltage level. The second objectives are to generate negatives ions by exposing air to high voltage. To achieve this objective, the fundamental of the voltage multiplier such as the principle, concept, types and characteristics of each type and the output waveform of each circuit is study. To solve the problem related to the low quality of air in a small room such as a lecture room, the suitable circuit by using Cockcroft Walton voltage multiplier is design, simulate and construct to prove the theoretical that has been covered.

1.3 PROBLEM STATEMENT

Nowadays, the quality of air is reducing many health problems to the mankind. Before the issues of air pollution became a hit, many scientists and researchers had noticed that the ionizations of even clean air can improve the quality of air. Basically, the clean air is consists of 78% nitrogen and 21% of oxygen, typically contain negative and positives ions in approximately 4-to-5 ratio. Those researchers found that whenever this ratio is charging, it will affect the biological system especially human.

The idea about the negative ions effect on human was popularized by a scientist named Fred Soyka, whom in 1970's had written a book title 'The ion effect'. In this book, he discussed about the natural occurrence of negative and positive ionized air. From his finding, he demonstrated that negatively ionizer air had substantial health benefits. He summarized hat the negatives ions helps elevate mood, enhance physical performance and training, and sterilized harmful airborne bacteria. On the other hand, the abundance of positives ions causing numbers of low grade medical problem, such as fatigue, headache and anxiety.

According to the research, many other scientists try to see other effect of the negative and positive ions to human and all the results showed that negatives ions give

many benefits compare to positives ions which give more bad effect to human. Here, this report tried to discuss about developing the negatives ions in a very practical method using Cockcroft-Walton voltage regulator circuit. The reason of this circuit is deign is to solve the problem related to the low quality air in a small area such as in a tutorial room or an office.

1.4 SCOPE OF WORK

The scope of work is very important for the execution of a project or a thesis. In this project, this section is divided into four sections.

1. To analyzed the fundamental of multiplier
    i. Search for information in books, internet sources and other.
    ii. To study about advantages and disadvantages of multiplier.
    iii. Analyze the information and make problem solving for the project development.
    iv. To study about the output waveform based on theory.

2. Design the related circuit for Cockcroft Walton Voltage Multiplier
    i. Change the value of component
    ii. Calculated the expected output.

3. Simulate the design circuit
    i. Using the Pspice and Multisim or other simulation programming.
    ii. The connection of each component will be checked.
    iii. Get the output value.
    iv. Determine the advantage and the disadvantage of the circuit.

4. Construct the circuit
    i. Construct the prototype of the circuit.
    ii. Compared the output with the simulation result.
    iii. Calculate the percentage different

5. Overall Test

    i. To make sure the air ionizer can operate as planned.
    ii. To make modification and development to the air ionizer if any problems occurred.

To achieve the objective of this project, the scope of work above must be follow. The simulation circuit and other source are use is based on Voltage Multiplier and Cockcroft-Walton Voltage Multiplier.

1.5 PROJECT METHODOLOGY

Firstly, search a literature review to collect more information about this project. The literature review will take journal, report, internet and books as it reference. To design a negative ionizer using the Cockcroft-Walton Voltage Multiplier circuit, the theory and all application about CW Voltage Multiplier circuit has been studies and understanding. Make a research about circuit theory and the characteristic of each component to redesign the CW circuit. Later, some literature review will used to compare this project with previous experiment and related project for this title.

Then, the circuit of CW Voltage Multiplier has been design by refer the literature review have found. To design the circuit, make sure the capacitor and diodes will used is more suitable for CW circuit to generate a high voltage. The design circuit will be simulated using the Pspice and Multisim software. The output voltage will be

measured and the calculated of the voltage is very important because it will determine the sum of component and stage that the circuit required to get the right output voltage.

After the design is successful, the circuit will be constructed on strip board. Make sure all connection of component at strip board is right. Then, check the circuit output voltage by using the multimeter and the value is compared with simulation output value. Then, the circuit has been constructed on PCB board. All connection in circuit is confirmed right before the soldering process. For last inspection, test the hardware if function or not. If not function, the circuit will be troubleshooting. If the circuit already functions, the model has been designed.