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And scientific research

Diyala university

College of engineering

Communication engineering department

Design and Implementation of a Wireless Cellular Phone Charger

A project

Submitted to the Department of Communication University of Diyala-College of Engineering in Partial Fulfillment of the Requirement for Degree Bachelor in Communication Engineering

By

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May 2016 Rajab 1436

قال تعالى

بسم الله الرحمن الرحيم

(وقل اعملوا فسيرى الله عملكم ورسوله

والمؤمنين وستردون الى عالم الغيب والشهادة

فينبئكم بما كنتم تعملون)

صدق الله العظيم

التوبة 105

الاهداء

الى سبيل من رزقنا الوجود، وامرنا بالسجود، الى الاحد المعبود، الى العدل الودود، الى الذي لا يملك غيره الخلود (الله جل جلاله)

الى من دنى فتدنى فكان قاب قوسين او ادنى الى نبي الرحمة (محمد صلى الله عليه وسلم)

الى من فرشت ايام عمرها طريقاً لإيصالي
الى من سهرت فصبرت طلباً لآمالي

الى من اضاءت لي عمرها لتنير لي كل الازمان

الى من طوقتني بالحب والحنان لتمحي كل الحرمان

الى من لولاها ماكنت هذا الانسان

(العزيزة الغالية امي الحبيبة)

الى قدوتي ومثلي الاعلى في حياتي

الى من اضناه العمر حتى رأني اكبر

الى من كان صبري حتى عجزت ان اصبر

(والدي العزيز)

الى من أرى فيهم ذاتي

(اخواني واخواتي)

الى من شاطرتهم فرحتي وحزني، واجمل سنين عمري

(اصدقائي)

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In The Name Of Allah, the Most Beneficent, the Most Merciful

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LIST OF ABBREVIATIONS

IC	**Integrated circuits**
PDAs	Person digital assistants
RF	Radio frequency

LIST OF SYMBOLS

VO	Out put voltage
RO	Internal resistance
RL	Load resistance
N	Number of stage
Q	Charge
C	Capacitance
V(t)	Total Voltage

ABSTRACT

This paper is the basis and design of the wireless battery charger. The wireless charger will convert the RF/ microwave signal at 900 MHz frequency into a DC signal, and then store the power into an A battery. The project is divided into 3 parts: transmitter, antenna, and charging circuit. A complete discussion of the specifications of the battery charger is provided after data measurements. This report also includes component list, financial, data results, and other key information.

SUPERVISORS CERTIFICATION

I certify that this project entitled "Design and implementation of a wireless cellular phone charger " was prepared under my supervision at the Communication Engineering Department/College of Engineering university of diyala by **(Zainab aboud salman, rafal khalied ahmed)** as a partial fulfillment of the requirements for the degree of B.SC. In communication Engineering.

Signature:

Name: DR. Montadar Abas Taher

Title: doctor

Date: / /2016

I certify that I have carefully read and corrected the final draft of this project for errors in punctuation, spelling and usage.

Proofreader's signature:

Date: / /2016

In view of the ability recommendation, I forward this project for the debate by the examining committee.

Signature:

Name: Dr. Montadar Abas Taher (Head of Dept.)

Title: doctor

Date: / /2016

<u>CERTIFICATION OF THE EXAMINATION COMMITTEE</u>

We certify that we have read this project entitled "***Design and implementation of a wireless cellular phone charger***" and as examining committee examined the students (**Zainab aboud salman, rafal khalied ahmed**) in its contents and that in our opinion it meets the standards of a project for the degree of B. Sc. in Communication Engineering.

Signature :	Signature:
Name :	Name:
Title :	Title:
Date: / /2016	Date: / /2016
(Member)	(Member)

Signature :

Name :

Title:

Date: / /2016
(chairman)

Approved for Communication Engineering Department.

Signature:
Name: **Dr. Montadar Abas Taher**
(Head of the Department)

Title: Lecturer
Date: / / 2016

1.1 Introduction

Cellular telephone technology became commercially available in the 1980's. Since then, it has been like a snowball rolling downhill, ever increasing in the number of users and the speed at which the technology advances. When the cellular phone was first implemented, it was enormous in size by today's standards. This reason is two-fold; the battery had to be large, and the circuits themselves were large. The circuits of that time used in electronic devices were made from off the shelf integrated circuits (IC), meaning that usually every part of the circuit had its own package. These packages were also very large. These large circuit boards required large amounts of power, which meant bigger batteries. This reliance on power was a major contributor to the reason these phones were so big. Through the years, technology has allowed the cellular phone to shrink not only the size of the ICs, but also the batteries. New combinations of materials have made possible the ability to produce batteries that not only are smaller and last longer, but also can be recharged easily However, as technology has advanced and made our phones smaller and easier to use, we still have one of the original problems: we must plug the phone into the wall in order to recharge the battery. Most people accept this as something that will never change, so they might as well accept it and carry around either extra batteries with them or a charger. Either way, it's just something extra to weigh a person down. There has been research done in the area of shrinking the charger in order to make it easier to carry with the phone. One study in particular went on to find the lower limit of charger size [1]. But as small as the charger becomes, it still needs to be plugged in to a wall outlet. How can something be called "wireless" when the object in question is required to be plugged in, even though periodically? Now, think about this; what if it didn't have to be that way? Most people don't realize that there is an abundance of energy all around us at all times. We are being bombarded with energy waves every second of the day. Radio and television towers, satellites orbiting earth, and even the cellular phone antennas are constantly transmitting energy. What if there was a way we could harvest the energy that is being transmitted and use it as a source of power? If it could be possible to gather the energy and store it, we could potentially use it to power other circuits. In the case of the cellular phone, this power could be used to recharge a battery that is constantly being depleted. The potential exists for cellular phones, and even more complicated devices - i.e. pocket organizers, person digital assistants (PDAs), and even notebook computers - to become completely wireless. Of course, right now this is all theoretical. There are many complications to be dealt with. The first major obstacle is that it is not a trivial problem to capture energy from the air. We will use a concept called energy harvesting. Energy harvesting is the idea of gathering transmitted energy and either using it to power a circuit or storing it for later use. The concept needs an efficient antenna along with a circuit capable of converting alternating-current (AC) voltage to direct-current (DC) voltage. The efficiency of an antenna, as being discussed here, is related to the shape andimpedance of the antenna and the impedance of the circuit. If the two impedances aren't matched then there is reflection of the power back into the antenna meaning that the circuit was unable to receive all the available power. Matching of the impedances means that the 2 impedance of the antenna is the complex conjugate of the impedance of the circuit

1.2 PROBLEM STATEMENT

Portable electronic devices are very popular nowadays. As the usage of these portable electronic devices is increasing, the demands for longer battery life are also increasing. These batteries need to be recharged or replaced periodically. It is a hassle to charge or change the battery after a while, especially when there is no power outlet around. Therefore, our team is inspired to design a wireless battery charger. This wireless battery charger is expected to eliminate all the hassles with today's battery technology

1.3 OBJECTIVE

The objective of our project is to design and implemen an energy conversion module for . Radio Frequency (RF) energy harvesting system at 900 MHz band

2.1 BACKGROUND

This project is based on the very simple energy concept , pick RF using the antenna , and inputs it into a pump and use this energy to run some of the other departments to use the results of the pumps existing charge to pay for other departments , are usually tested using photovoltaic cells transmitted RF energy to the circuit the charge pump energy stores in intensive large . , Photovoltaic cells use stored energy to light for a moment . This is called the discount system .. This type of technology is very useful in the Radio Frequency Identification Applications (RFID). RFID systems work the way it is when it passes through the chip scanner device, the power is sent to the segment of the scanner. In older systems, the modulation frequency or amplitude of this signal from the pre-sliced and return it. This technique is called regressive. However, in more recent systems, chips become increasingly complex and require more energy to run. RFID is not suitable for batteries system is mostly because they have to be small, but also because the batteries will eventually die and requires change. But, with a good antenna, it should be able to charge to deal with the energy savings from these constituencies pump will need to be serviced. Because the circuit is small, and the energy required is minimal

2.2 THE ANTENNA

The dipole antenna or dipole aerial is one of the most important and commonly used types of RF antenna.The dipole aerial or antenna is widely used on its own,as shown in figure 2.1, but it is also incorporated into many other RF antenna designs where it forms the radiating or driven element for the overall antenna.The dipole is a simple antenna to construct and use, and many of the calculations are quite straightforward. However like all other antennas, the in-depth calculations are considerably more complicated.

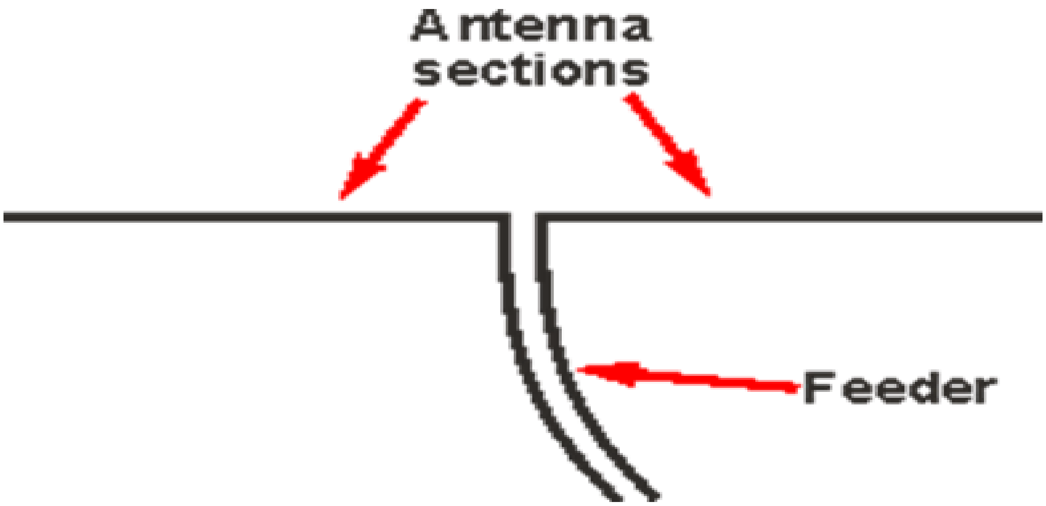


Figure 2.1:dipole antenna

The current and voltage on a radiating element vary along the length of the dipole. This occurs because standing waves are set up along the length of the radiating element and as a result peaks and troughs are found along the length.

The current and voltage on a radiating element vary along the length of the dipole. This occurs because standing waves are set up along the length of the radiating element and as a result peaks and troughs are found along the length.

The current falls to zero at the end and rises towards the middle. Conversely, the voltage peaks at the end and falls as the distance from the end increases.

Both the current and voltage on the dipole antenna vary in a sinusoidal manner, meaning that there may be other peaks and troughs along the length of the radiating sections dependent upon their length.

The most popular form of dipole antenna is the half wave and for this As it is shown in Figure 2.3, the current is at a minimum at the ends and rises to a maximum in the middle where the feed is applied. Conversely the voltage is low at the middle and rises to a maximum at the ends. It is generally fed at the centre, at the point where the current is at a maximum and the voltage a minimum. This provides a low impedance feed point which is convenient to handle. High voltage feed points are far less convenient and more difficult to use.

When multiple half wavelength dipoles are used, they are similarly normally fed in the centre. Here again the voltage is at a minimum and the current at a maximum. Theoretically any of the current maximum nodes could be used.

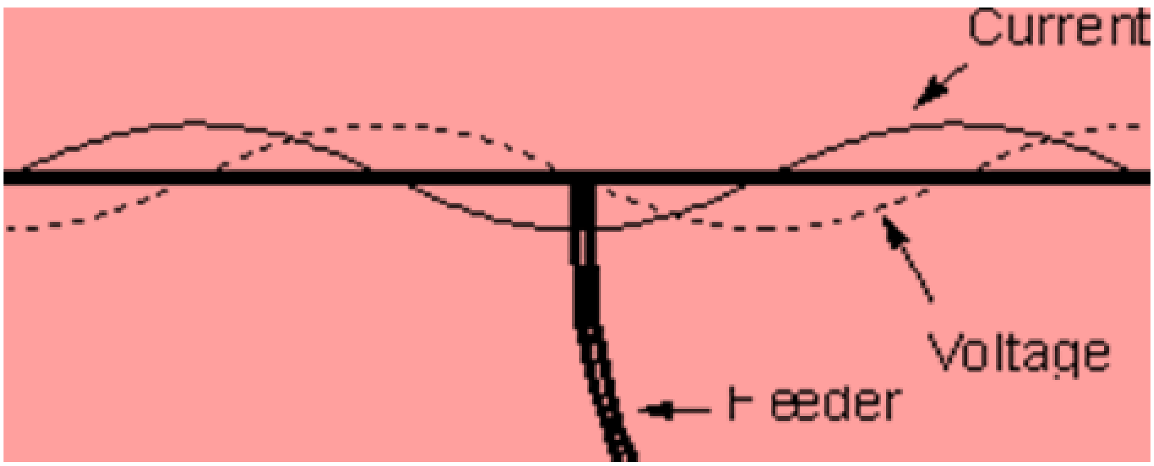


Figure 2.3:dipole antenna is the half wave

2.3 THE PHONE

The design aspect of this project is focused on the receiving side. For this stage of research, of which the goal is to prove that the wireless battery charger idea is feasible, it was decided to incorporate the energy harvesting circuitry and antenna in some sort of base station or charging stand. It is necessary to hide the components for demonstration purposes. The Nokia 3570 in figure 2.1, was the first phone that was received for the research. This phone comes standard with a battery and an AC/DC travel charger. The battery included with the phone has a voltage range from 3.2V - when the phone shuts off - to 3.9V when fully charged. This battery only takes about 2 hours to charge when plugged into the wall through the travel charger supplied with the phone. This charger has an unloaded, unregulated direct current (DC) output voltage of 9.2V. When connected to the phone, the charging voltage goes to the battery voltage, approximately 3.6V, and then slowly increases until it saturates at 3.9V. This charger regulates the current to around 350mA

Figure 2.1:wireless charger

2.4 THE TRANSMITTER

Called the transmitting antenna patch antenna fabricated from copper soldered to the wire feed coating. The 900MHz frequency has been selected for this project, a short distance experimentation. It has been chosen this frequency mostly for simplicity in the use of equipment available. It is not used to connect to a block or anything else on a large scale, and therefore is not going to interfere with, or interfere with other devices in the low-energy levels. This also means that the transmitters for short distances are readily available. In fact, 900MHz frequency is very common used in RF research. This makes the transmitter system easy to build and manage. Source is nothing more than a signal generator, is able to output a signal AC- low noise and works at 900MHz antenna on the

receipt of waves and sent to the AC circuit

3.1 INTRODUCTION

RF energy harvesting is one type of energy harvesting that can be potentially harvested such as solar, vibration and wind. The RF energy harvesting uses the idea of capturing transmitted RF energy at ambient and either using it directly to power a low power circuit or storing it for later use. The concept needs an efficient antenna along with a circuit capable of converting RF signals to DC voltage. The efficiency of an antenna mainly depends on its impedance and the impedance of the energy con- verting circuit. If the two impedances aren't matched then it will be unable to receive all the available power from the free space at the desired frequency band. Match- ing of the impedances means that the impedance of the antenna is the complex conjugate of the impedance of the circuit (voltage doubler circuit).

The concept of energy harvesting system is shown in Figure 3.1, which consists of matching network, RF-DC conversion and load circuits. work was carried out on a firm frequency of 900 GHz The energy conversion module designed in this paper is based on a voltage doubler circuit which can be able to output a DC voltage typically larger than a simple diode rectifier circuit, in which switched capacitor charge pump circuits are used to design two phase volt- age doubler and a multiphase voltage doubler. The voltage doubler presented in this can function as an AC to DC con- verter that not only rectifies the input AC signal but also elevates the DC voltage level. The output voltage of the energy conversion module can be used to energize the low power devices

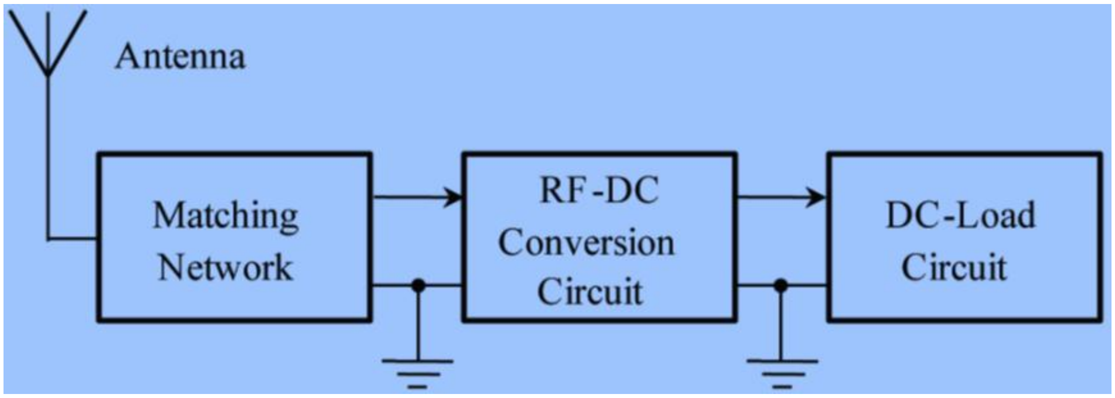


Figure:3.1: RF energy harvesting system

3.2 THE CHARGE PUMP

voltage doubler because in theory, the voltage that is received on the output is twice that at the input. The schematic in Figure 3.2, represents one stage of the circuit. The RF wave is rectified by D2and C2 in the positive half of the cycle, and then by D1 and C1 in the negative cycle.But, during the positive half-cycle, the voltage stored on C1 from the negative half-cycle is transferred to C2. Thus, the voltage on C2 is roughly two times the peak , voltage of the RF source minus the turn-on voltage of the diode, hence the name voltage doubler. The most interesting feature of this circuit is that by connecting these stages in series, we can essentially stack them, like stacking batteries to get more voltage at the output. One might ask, after the first stag

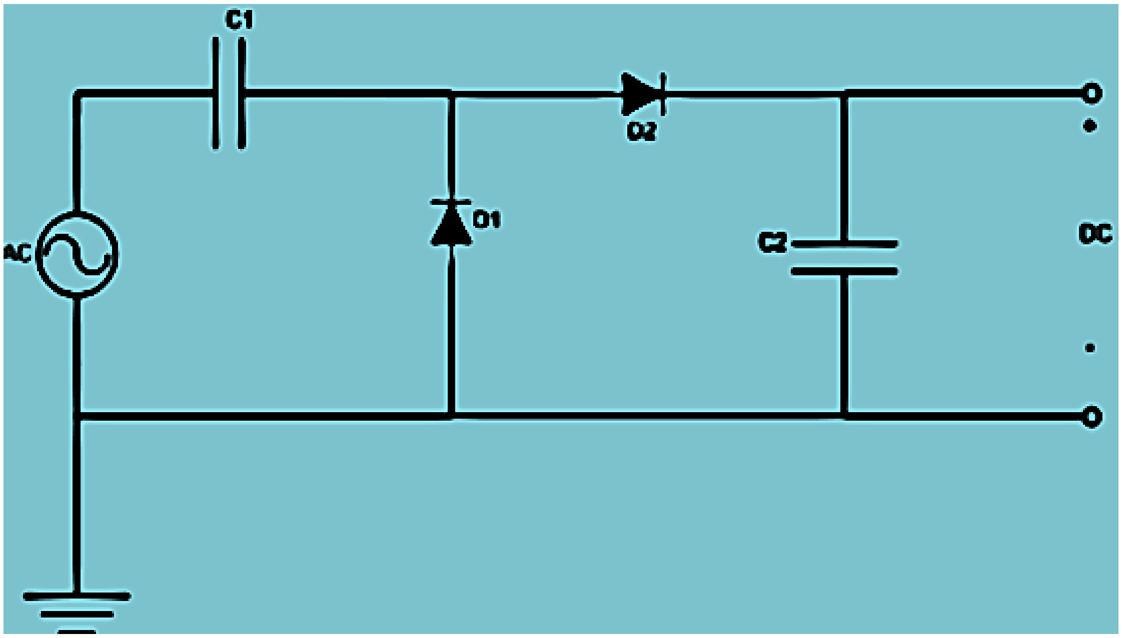


Figure 3.2: Voltage Double

an AC signal with a DC offset. This is equivalent to saying the DC signal contains noise. This can be seen in Figure 3.3. This is where the other stages come in. If a second stage is added on top of the first, the only wave that the second stage sees is the noise of the first stage. This noise is then doubled and added to the DC of the first stage. Therefore, the more stages that are added, theoretically, more voltage will come from the system irregardless of the input. Each

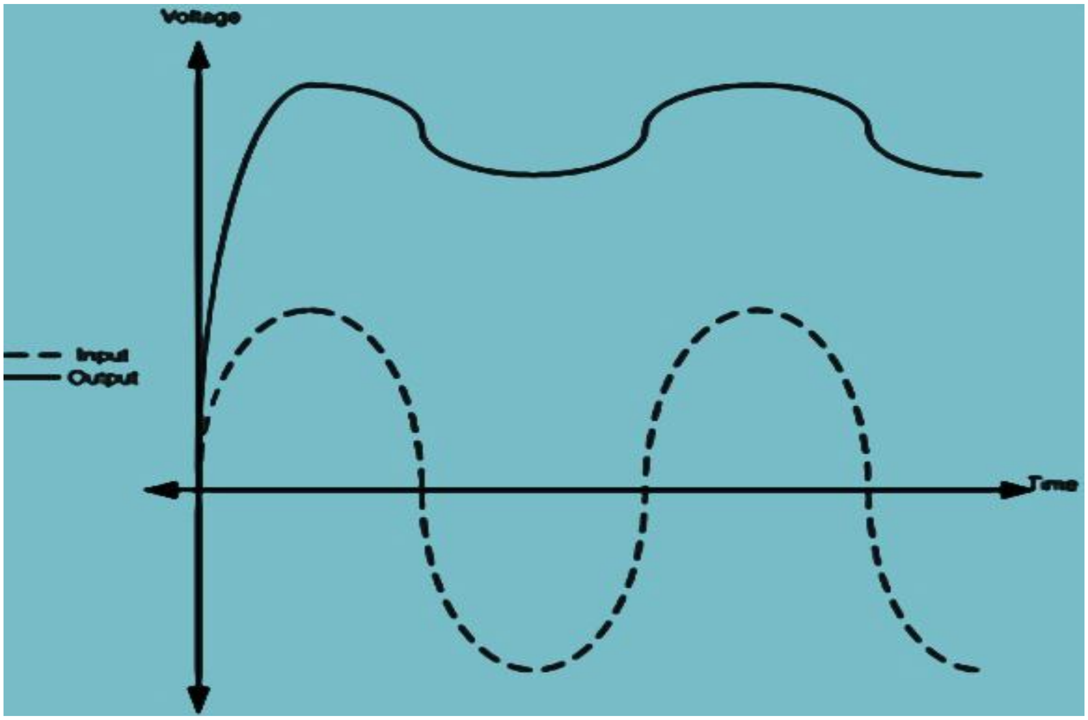


Figure 3.3: Voltage Doubler Waveform

independent stage, with its dedicated voltage doubler circuit, can be seen as a battery with open circuit output voltage V_O and internal resistance R_O. When n of these circuits are put in series and connected to a load of R_L, the output voltage will be given by Equation (1).

Eq (3.1)

$$Vout = \frac{nVo}{nRo + RL} RL = \; Vo \; \frac{1}{\frac{Ro}{RL} + 1/n}$$

From Equation (1), we know that the output voltage Vout is determined by the addition of R0/RL and 1/n if V0 is fixed [2]. With VO, RO, and RL all constants, we can see from the equation that as n increases, the increase in output voltage will be less each time. At some point, the voltage gained will be negligible.

3.3 Number of stages

The number of stages , as shown in figure 3.4,in the system has the greatest effect on the output voltage .the capacitance, both in the stages and at the end of the circuit, affects the speed of the transient response and the stability of the output signal. The number of stages is essentially directly proportional to the amount of voltage obtained at the output of the system. Generally, the voltage of the output increases as the number of stages increases

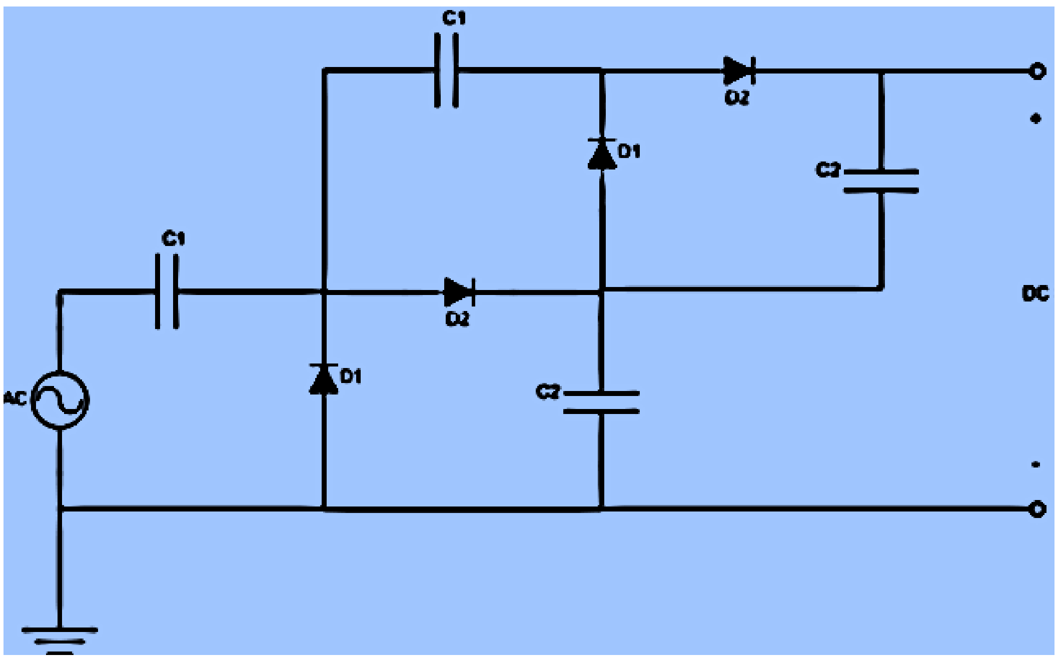


Figure3.4: 2Stages of Voltage Doubler

3.4 STAGE CAPACITANCE

The stage capacitance , Figure 3.5, is difficult to work with. Sometimes, minimal changing of the Capacitance will have a drastic effect on the output voltage. But, other times the change is negligible. The capacitance parameter is definitely very sensitive. To change the capacitance of each stage in the system required resoldering of all the capacitors. This is especially difficult and time consuming when working with surface mount components. The surface mount capacitors were used to make the board and overall system as small as possible. Empirical testing can be a bit tedious. There are a couple of different values that can be used for the capacitance. The first and most obvious, is to keep all the values in all the stages the same. A second way is to gradually decrease the value of the stage capacitors as the number of stages increases. Each stage uses two capacitors,

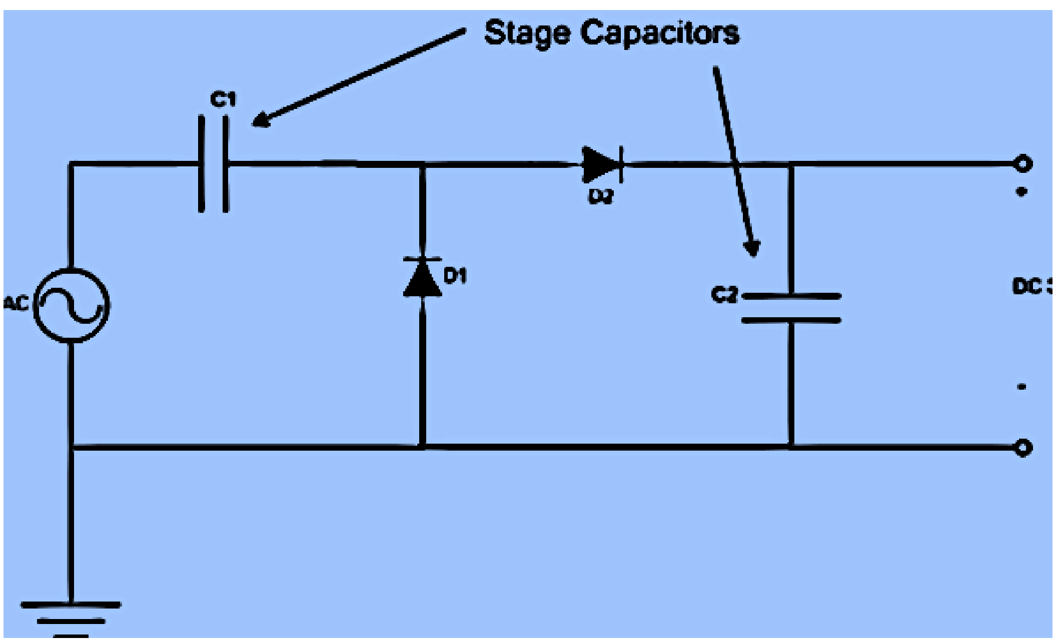


Figure 3.5: Stage Capacitor of Voltage Doubler

This comes from the equation for charge in a capacitor, Equation (2)

$$Q = C * V(t) \qquad Eq\ (3.2)$$

In Equation (2), the voltage in a capacitor is inversely proportional to the capacitance with relation to the charge. This being the case, if the voltage in a system increases, it would stand to reason that a lower capacitance value would be needed to keep the same charge.

3.5 output capacitance

The variable that has the least affect on the overall system is the output capacitance as shown in Figure 3.6, Generally, the value of this capacitor only affects the speed of the transient response. The bigger the value for the output capacitance, the slower the voltage rise time. This does not mean, however, that the smallest capacitor will work the best, or that no capacitor should be used. Without a capacitor there, the output is not a good DC signal, but more of an offset AC signal, meaning that it will be DC with ripple.

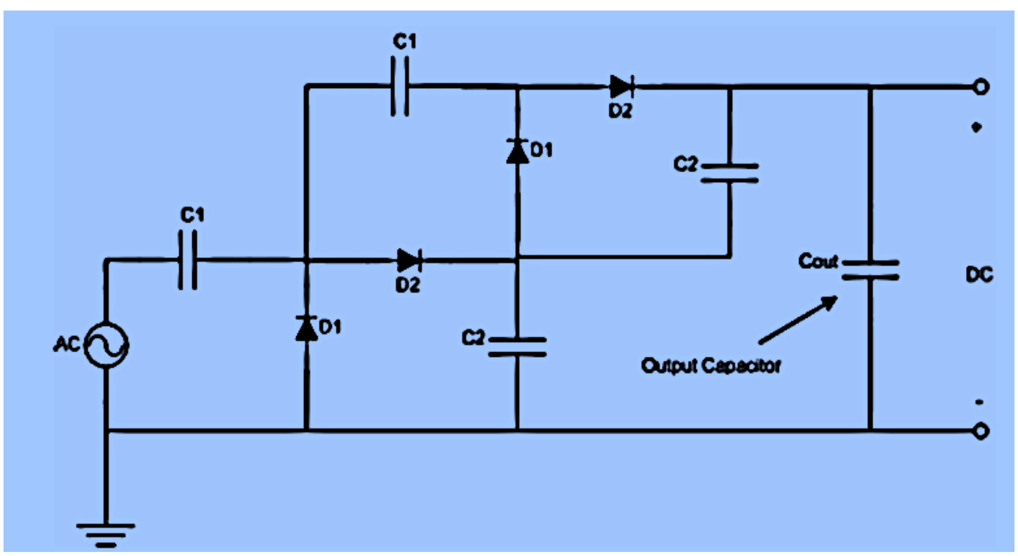


Figure 3.6:Voltage Doubler with Output Capacitor

3.6 Multisim is used for the modeling and simulation work.

Ansoft Designer is used much like any other circuit modeling and simulating program. The components are placed and wired together into a coherent circuit, given specified values, and then simulations are run over and over while changing the variables in the circuit. This is the standard way to simulate circuits in most programs, including those that use SPICE. However, this software has a convenient feature that most SPICE programs do not have. This feature is the ability to optimize, or tune, certain variables during simulation. This tuning function allows you to specify a range of values for all variables in the circuit, including all component values, and tests them all at certain increments specified by the user. This comes in handy for a circuit like the one under consideration., we have two ways to manage the stage capacitance. The first is to keep all stages the same value. This is the simplest. The other way is to vary the stage capacitance between stages based on the charge in the circuit. This software gives us an easy mechanism to simulate both of these ways in the same simulation and compare the results.

The only variable that can not be optimized easily with this software is the number of stages. This means that simulations need to be performed for every change in the number of stages

The first thing to be done was to lay out all the components in an organized fashion so that the circuit can be easily., it was chosen not to display the circuit as in previous figures, but in a stackable, left-to-right design. The first schematic is a 12stage design with all the stage capacitors being the same value. Starting on the left to right as shown in figure 3.7

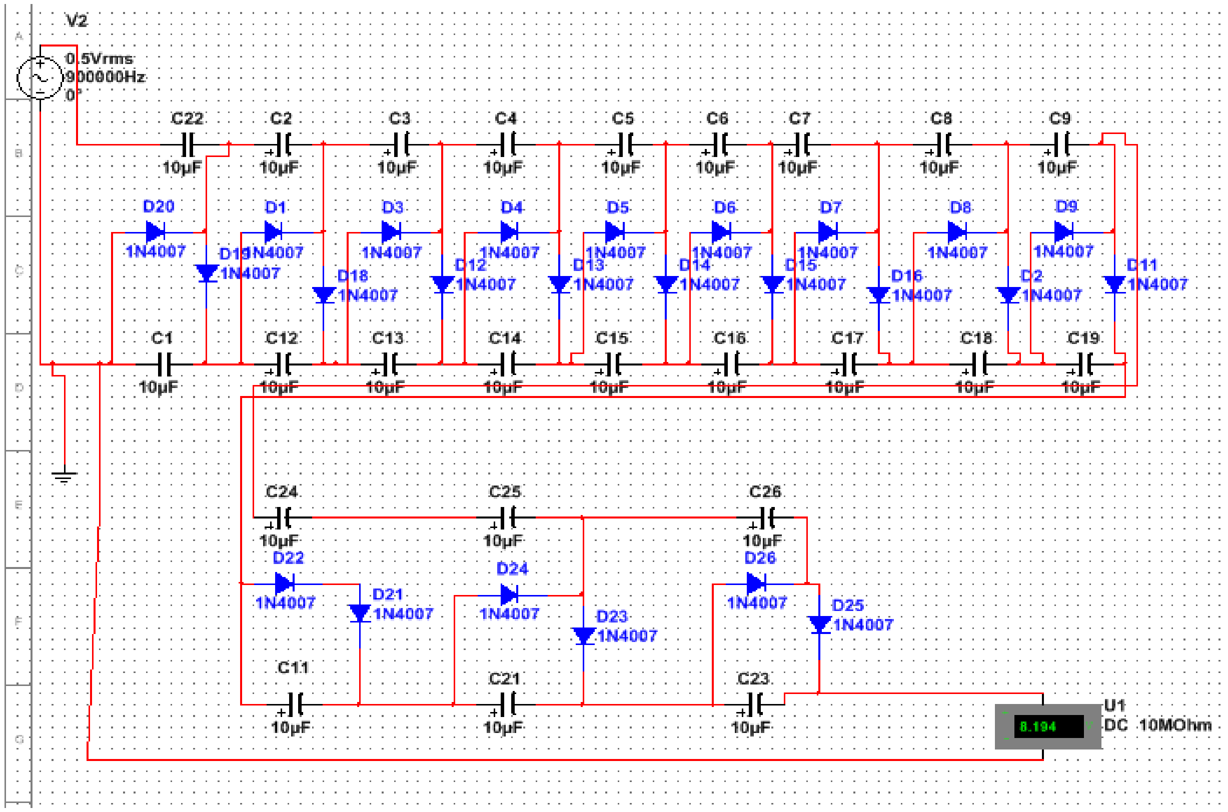


figure 3.7: Ansoft Designer

At the right of the circuit, the output capacitor is connected to the circuit and to ground. The object that is shown before the output capacitor is a voltage probe. This is a program specific device that acts as a voltage meter, and it is necessary in the circuit to be able to see the voltage on that connection after the simulation has been completed. This program uses what it calls "reports" to show the results of the simulation. It is not necessary for the reports that the probes available in the program be used in the schematic because all the connection points of the circuit can be displayed.

3.7 A 12 stage Schottky diode voltage doubler circuit

The 12 stage voltage multiplier circuit design imple- mented in this paper is shown in Figure 3.8,Starting on the left side, there is a RF signal source for the circuit followed by the first stage of the voltage multiplier cir- cuit. Each stage is stacked onto the previous stage as shown in the Figure 3.8, Stacking was done from left to right for simplicity instead of conventional stacking from bottom to top.

The circuit uses eight zero bias Schottky surface-mount Agilent, HSMS-4700 diodes. The special features of these diode is that, it provides a low forward voltage, low substrate leakage and uses the non- symmetric properties of a diode that allows unidirec- tional flow of current under ideal conditions. The diodes are fixed and are not subject of optimization or tuning. This type of multiplier produces a DC voltage which depends on the incident RF voltage. Input to the circuit is a predefined RF source. The voltage conversion can be effective only if the input voltage is higher than the Schottky forward voltage.

The other components associated with the circuit are the stage capacitors(10uF).

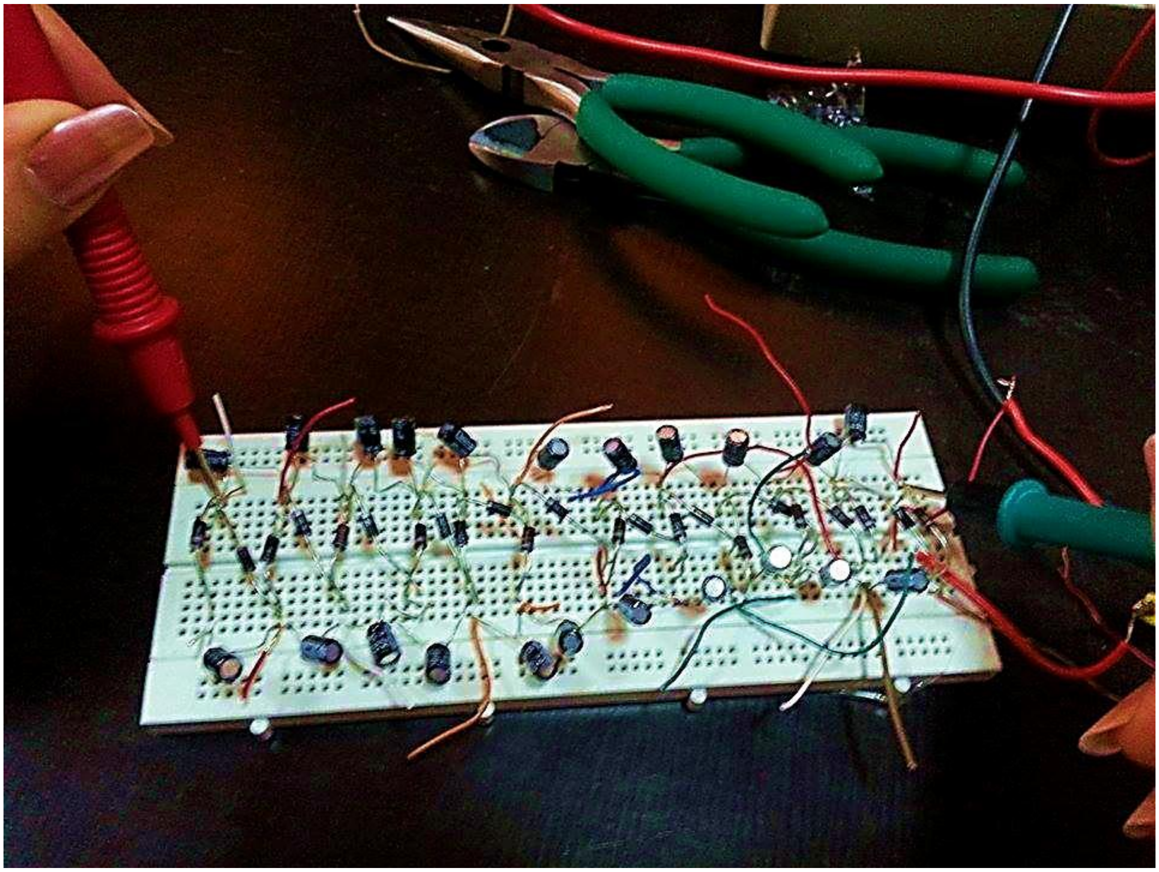


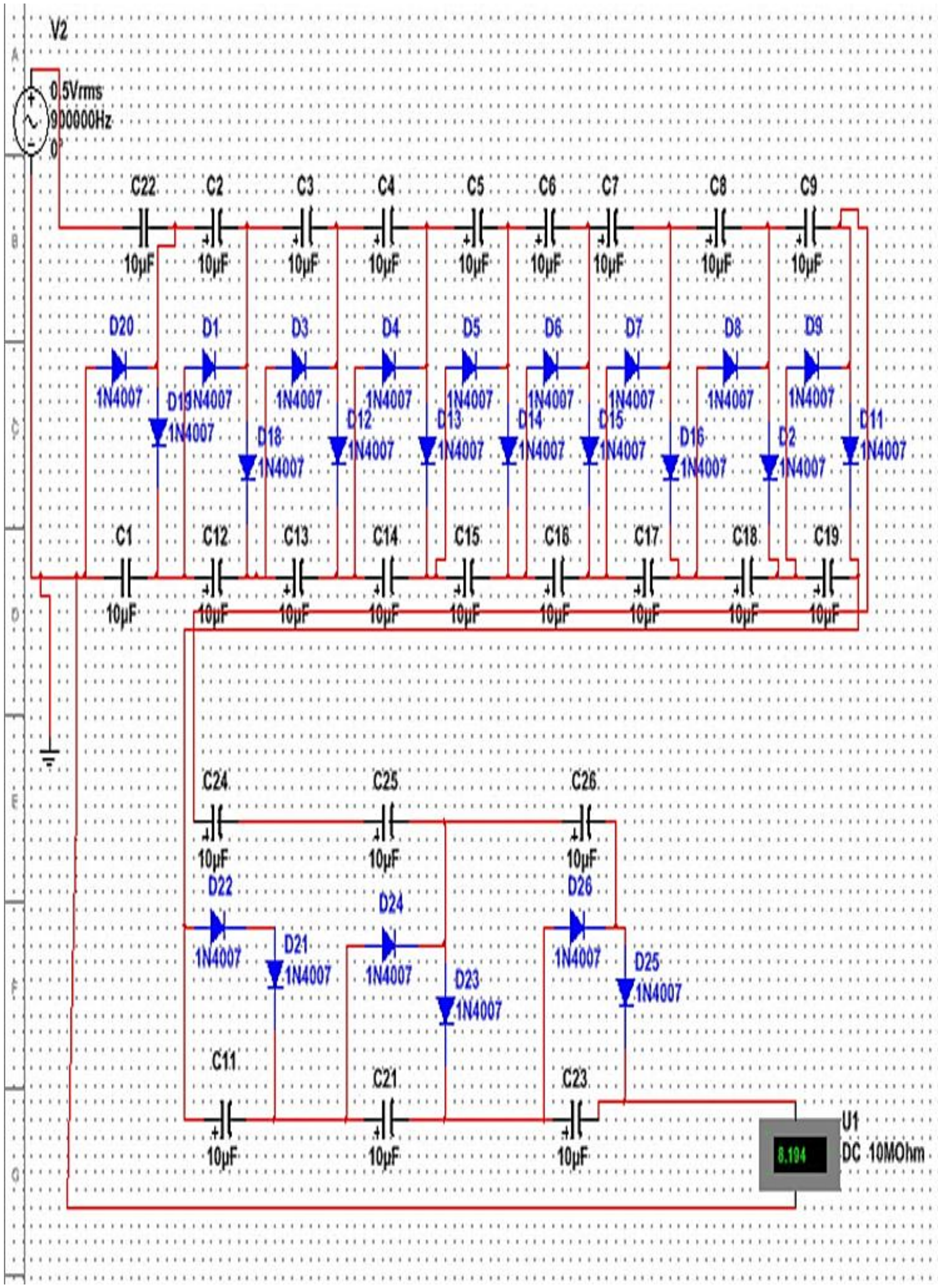
Figure 3.8:A 12 stage Schottky diode voltage doubler circuit

4.1 Introduction

After the completion of the 12- stage virtually the circuit design of each stage consisting of diode type and a widening 10u F been working on laboratory- circuit and so Bttaghir circuit frequency of 900 MHz and voltage value of half volt AC just to make sure that the circle Vtm measurement device voltage Lemaitre voltage recorded for each phase voltage emerging Vaallantijaj recorded for each voltage Mrahlha are shown in table either voltage beyond 5 volts was worth a doubling several times the value of the input voltage value Ozk because each stage represents b multiplier voltage (voltage doubler) After reading the final value of Volth emerging been confirmed and the results of the tagecomparison voltage Almaltesm registered for using the program and the results were almost identical and are considered emerging voltage values obtained both ways sufficient to charge the battery nigeriawap note that the battery out of your mobile

4.2 The resulte of Multisim

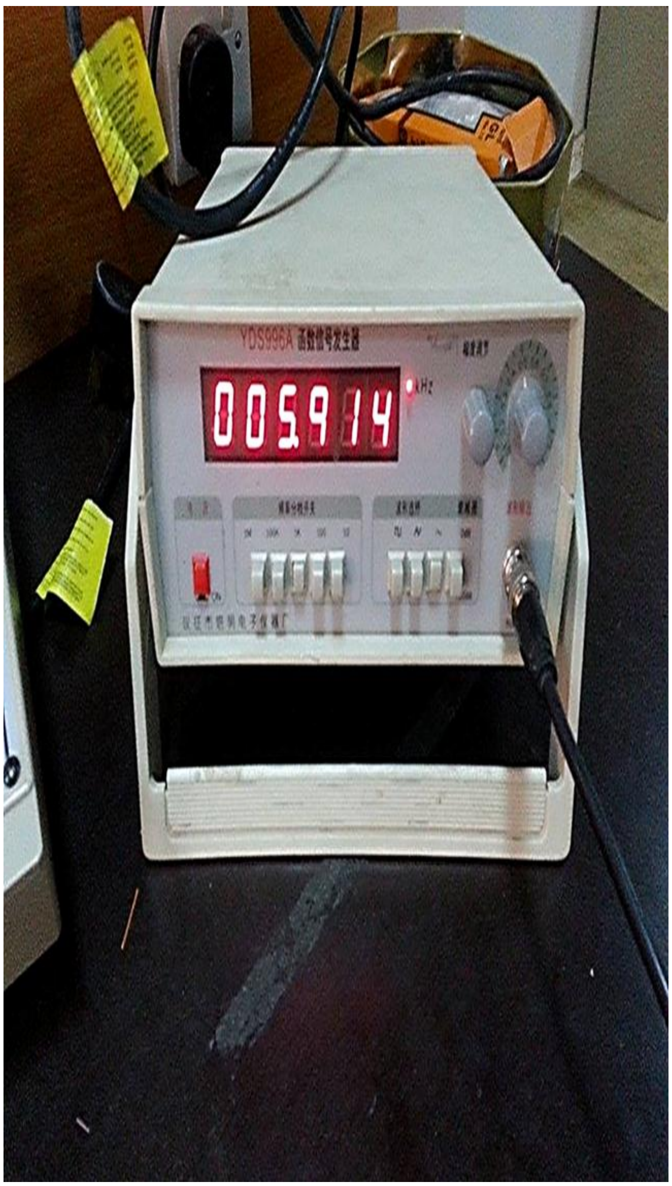
The result obtained is committed to using the program multisim is 8.194V which is close to its practical value as shown in figure 4.1.

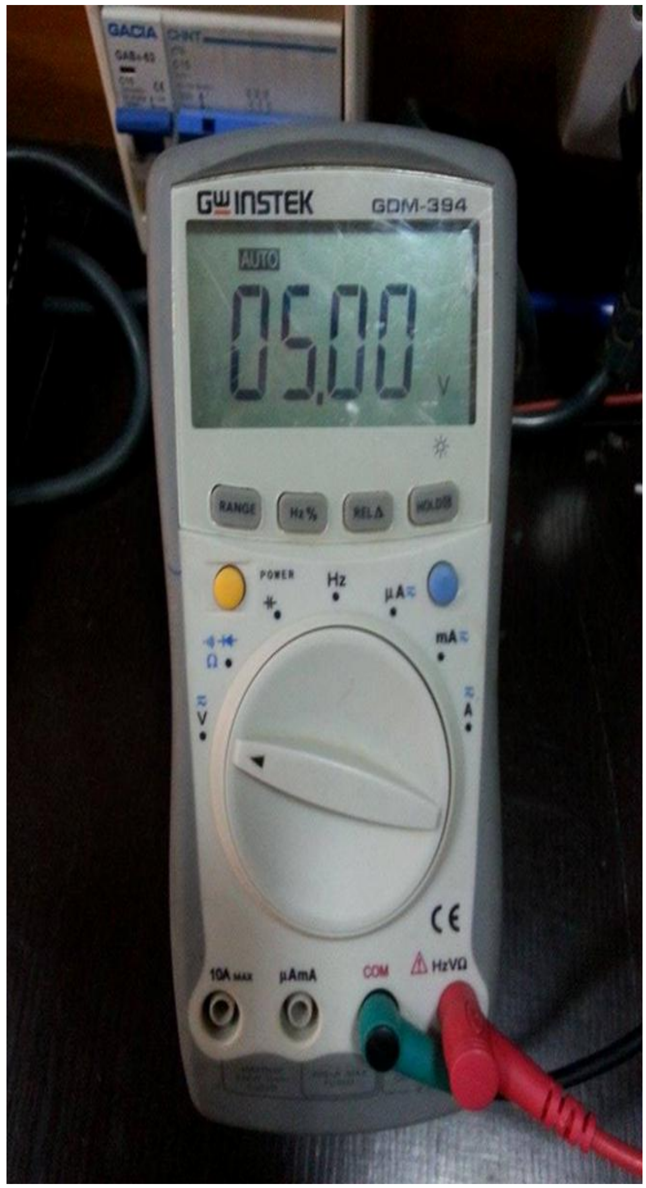


Figuer 4.1: The resulte of Multisim

4.3 The resulte of experimentally

The result obtained experimental is 5V DC the Frequency 900MHZ an approach to the value of multisim ashown in figure 4.2.





Figuer 4.2:the Frequency 900MHZ   Figuer 4.3:the final volteg of 12 stage

Table(4.1) Result

Number of stage	**Voltage value**
Stage1	0.65V
Stage2	1.11V
Stage3	1.41V
Stage4	1.75V
Stage5	2.17V
Stage6	2.49V
Stage7	2.92V
Stage8	3.27V
Stage9	3.79V
Stage10	4.13V
Stage11	4.49V
Stage12	5.00V

5.1 Conclusion

In this project, we submit a first step towards a goal that would have profound ramifications on the cellular phone industry and the portable electronic device industry as a whole. Experimental results show that while we were not completely successful at achieving our overall goal of having the charging circuit in a stand be able to charge the battery of a cellular phone while it was within the phone using a wireless RF source, we have completed the goal of being able to charge the battery while existence the battery outside the phone Circumventing the proprietary circuitry in the charging path will allow future adaptation of the wireless RF energy harvesting

5.2 Future work

The most important result is that I successfully proved that the concept of charging cell phone battery while using the phone outside the RF energy harvesting possible. We were able to get enough power to run the phone. This is an important result because it shows that the circuit that was designed, simulated and tested throughout this research can be used to achieve our ultimate goal. Because of this result, it can be expected in the future work in this area. It is likely that with the increased focus on the antenna, and as the energy harvesting technology becomes more advanced, this work be successful in achieving a commercial product. The ultimate goal, of course, is to get everything on the phone and use the surrounding RF energy to charge the battery. We have laid the foundation for this work to continue through the following objectives: We were able to directly charge the battery faster than had been done in the past. We were able to run the phone using the phone and sent to stand up radio signals . We made simulated and experimental data that can be used as a reference for future work in the region. And we were able to intensify circuits to a small size enough to hide the circles shipping and antenna inside position commercially available Involved in achieving these goals is the circuit in an appropriate program to simulate circuits for high- frequency modeling , The panel design testing necessary to verify the simulation results and procedures , and finally the creation of a combination of the Governing Council and the antenna , which will be small enough to be featured in a position commercially available , yet to be able to show that in fact we are able to power the phone.

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الخلاصة:

الهدف الرئيسي من هذا المشروع تعظيم الاستفادة من مراحل الجهد مضاعف في وحدة تحويل الطاقة لنظام ترددات الراديو (RF) حصاد الطاقة في 900 ميغاهرتز. وظيفة وحدة تحويل الطاقة هي لتحويل الإشارات (RF) إلى (DC) الجهد التيار المباشر في تردد معين لتشغيل أجهزة الطاقة المنخفضة الدوائر. ويستند علامة اجتثاث على فيلارد دائرة الجهد مضاعف.

وزارة التعليم العالي والبحث العلمي

جامعة ديالى

كلية الهندسة

قسم هندسة الأتصالات

تصميم وتنفيذ شاحن الهاتف الخليوي اللاسلكية

مشروع

مقدم الى قسم هندسة الأتصالات

في جامعة ديالى – كلية الهندسة كجزء من متطلبات نيل درجة البكلوريوس

في هندسة الأتصالات

من قبل

زينب عبود سلمان

رفل خالد احمد

بأشراف

د.منتظر عباس طاهر

May/2016 **رجب/1434**