Designing of Wireless Mobile Battery Charger

A Project report submitted in partial fulfilment
Of the requirements for the degree of B.Tech. in Electrical Engineering

By

Debosmita Mondal (EE2020L02)
University Roll No: 11701620035

Sayan Ghosh (EE2020L11)
University Roll No: 11701620025

Sukanya Mitra (EE2020L09)
University Roll No: 11701620027

Under the supervision of

Prof. (Dr.) Debasish Mondal
Dept. of Electrical Engineering

श्रमम् बिना न किमपि साध्यम्

Department of Electrical Engineering

RCC INSTITUTE OF INFORMATION TECHNOLOGY

CANAL SOUTH ROAD, BELIAGHATA, KOLKATA - 700015, WEST BENGAL
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Name and Signature of the Student:

DEBOSMITA MONDAL
Reg. No.: 201170101620001
Roll No.: 11701620035
B. Tech (EE)

SUKANYA MITRA
Reg. No.: 201170101620009
Roll No.: 11701620027
B. Tech (EE)

SAYAN GHOSH
Reg. No.: 201170101620011
Roll No.: 11701620025
B. Tech (EE)

Certificate

To whom it may concern:

This is to certify that the project work entitled **"Design of Wireless Mobile Charger"** is the bonafide work carried out by **Debosmita Mondal (EE2020L02), Sukanya Mitra (EE2020L09) and Sayan Ghosh (EE2020L11)** students of B.Tech. in the Dept. of Electrical Engineering, RCC Institute of Information Technology (RCCIIT), Canal South Road, Beliaghata, Kolkata-700015,affiliated to Maulana Abul Kalam Azad University of Technology (MAKAUT), West Bengal, India, during the academic year 2022-23, in partial fulfilment of the requirements for the degree of Bachelor of Technology in Electrical Engineering and that this project has not submitted previously for the award of any other degree, diploma and fellowship.

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Signature of the Guide
Name:
Designation:

____
Signature of the HOD
Name:
Designation:

____
Signature of the External Examiner
Name:
Designation:

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Abstract

This project presents the conception and construction of a wireless mobile charger using inductive coupling. To achieve the desired objective, the electronics components and materials used were an N-channel MOSFET, rectifier diodes, voltage regulator, resistors, capacitor, enamelled copper wire and DC voltage source. The project consists of two circuits: A transmitter circuit and a receiver circuit. The transmitter circuit consists of DC source, oscillator circuit and a transmitter coil, and its function is to produce and transmit AC power. The receiver circuit consists of receiver coil, rectifier circuit and regulator. When the receiver coil is placed at a distance near the inductor AC power is induced in the coil. This is rectified by the rectifier circuit and is regulated to DC 5V.

1. Introduction:

The electricity is playing an important role in each and every step in our daily life. Based on the utilisation of electricity emerging technologies and appliances are growing up which making our life simpler day by day. It is well known that the introduction and extensive service of the mobile phone in different ways changing the human life very rapidly. Although there are found rapid advancements in the technologies, people are still being relied on the wired battery charging system. Besides mobile phone different portable electronic devices, gadgets, tablets, laptops, household robots, drones etc. also run by the battery power. Wireless charging is also known as inductive charging. It basically allows you to power any compatible device by placing it on a charging spot. It works with electromagnetic fields that allow transferring energy between two devices. A transmitter is connected to a power source, and through an induction coil generates an electromagnetic field. When a receiver is put within the range of the transmitter, it receives the energy that is transformed in electric current. All phone shave its own battery charger. It is need to carry everywhere to charge phone and keep the battery backup which is really a hectic and hassle job. Besides that the mobile phone need to fix near the plug in power point. To avoid these difficulties if it is possible to charge the mobile phone automatically sitting in any place in office or in tea table or if possible to continue work with walking and carrying mobile phone without plugging and then it will be very easier and hassles free. Thus, there is need to find a new technology which can make free the use of clumsy cables and the bulky physical charger. This article designs a simple wireless battery charging system which charges a mobile phone when placed near the wireless power transmitter. The present design may be utilised for wireless power transfer (WPT) system, wireless mobile charger or wireless battery charger system etc.

2. Literature Survey:

Conventionally, cables or wires are employed to transport electrical power from one place to another or one device to other device. However, it is well known the difficulties and burden of handling wires in electric power transmission systems. The transmission wires not only causes substantial power losses but also there are always possibility of breakage or damage due to environmental issues and other factors. Besides it there may be certain region where the installations of wired systems are not possible geographically. Hence, it is very essential to transport power between two pints without utilisation wires and transmission lines. Several attempts have been made by the researchers to address this issue [1]-[3]. Some researchers have done extensive review work in [4]-[5] to outline a path from the inception of this technology to the current technology is being used for wireless power transfer. The design and control of inductive power transfer system has been demonstrated in [6] where an efficient compensation topology has been utilised for Wireless Power Transfer (WPT).A working model for mobile charging using wireless power transmission has been proposed in [7]. Where an efficient power transfer with low voltage over a shorter distance is made possible for the mobile users. A conceptual review of WPT theory along with its technological solutions for Electric Vehicle battery chargers has been performed demonstrated in [8].A comprehensive topological has been demonstrated in [9] for the charging of plug-in electric vehicles (PEV). The concept of conductive or inductive charging has been utilised depending on the type of applications. The issue of misalignments in lateral and longitudinal directions of wirelessly charged electric vehicles have been addressed in [10] with help of mounting two auxiliary coils on the receiver end. An experimental prototype also has been developed for a 250 W system. This article designs a simple wireless battery charging system which charges a mobile phone when placed near the wireless power transmitter. A PROTEUS based simulation of the proposed prototype has been investigated before design of the actual hardware model. The present design may be utilised for wireless power transfer (WPT) system, wireless mobile charger or wireless battery charger system etc.

3. Theory:

For better comprehension theories related to Magnetic Resonant Coupling, quality factor and optimization techniques for wireless power transfer systems are presented here along with the working principles and constructions of various components. Magnetic coupling is an old and well understood method in the field of wireless power transfer. But as the magnetic field decay very quickly, magnetic field is effective only at a very short distance. By applying resonance with in magnetic coupling the power transfer at a greater distance can be obtained. For near field wireless power transfer, Magnetic resonant coupling can be the most effective method than any other method available. The block diagram for the whole experiment is shown below. It is consisting of an AC source, rectifier, oscillator, transmitter, secondary sources and load coil. It is observed that the voltage of 220V is connected to the transformer. The transformer is then connected to the transmitter circuit as a source of supply. The (Fig .1) block diagram choose the proposed circuit of wireless mobile charge

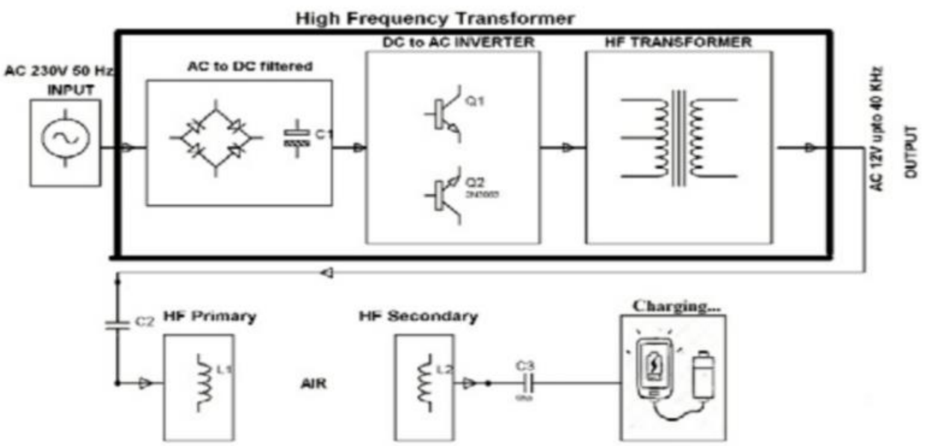

Fig.1 Block diagram of the proposed circuit

William C. Brown has designed, developed a unit and demonstrated to show how power can be transferred through free space by microwaves. In the transmission side, the microwave power source generates microwave power and the output power is controlled by electronic control circuits. A. Inductive or Magnetic Coupling Inductive or Magnetic coupling works on the principle of electromagnetism. Transferring energy between wires through magnetic fields is inductive coupling. If a portion of the magnetic flux established by one circuit interlinks with the second circuit, then two circuits are coupled magnetically and the energy may be transferred from one circuit to another circuit. This energy transfer is performed by the transfer of the magnetic field which is common to the both circuits. Fig .2 shows Magnetic Coupling.

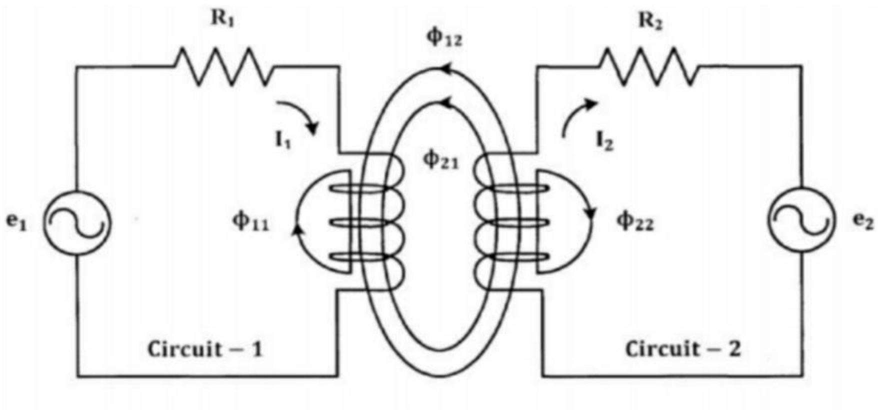

Fig.2 Magnetic Coupling with four component fluxes

3.1 Magnetic Resonant Coupling:

Magnetic Resonant coupling uses the same principles as inductive coupling, but it uses resonance to increase the range at which the energy transfer can efficiently take place. Resonance can be two types: (a) series resonance & (b) parallel resonance. In these both types of resonance the principle which is to get maximum energy transfer is same but the methods are quite different. Equivalent magnetic resonant coupling is shown in Fig.3.

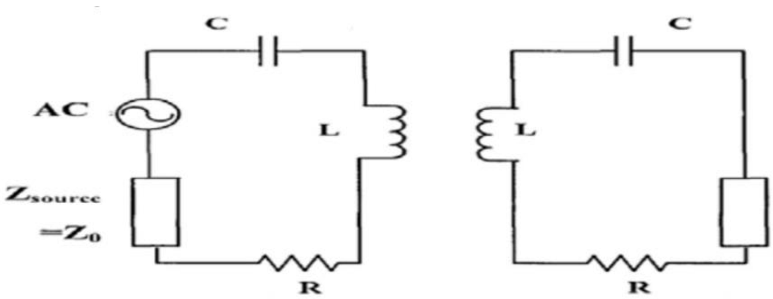

Fig .3 Equivalent Circuit of Magnetic Resonant Coupling

Resonance is a phenomenon that causes an object to vibrate when energy of a certain frequency is applied. In physics, resonance is the tendency of a system (usually a linear system) to oscillate with larger amplitude at some frequencies than at others. These are known as the system's resonant frequencies. In these particular frequencies, small periodic driving forces even can produce oscillations having large amplitude. D. Quality Factor In physics and engineering the Quality factor (Q -factor) is a dimensionless parameter that describes the characteristics of an oscillator or resonator, or equivalently, characterises a resonator's bandwidth relative to its central frequency. Higher Q indicates the stored energy of the oscillator is relative of a lower rate of energy loss and the oscillations die out more slowly. So it can be stated that, Oscillators with high quality factors have low damping so that they pendulum ring longer, in case of a pendulum example. In an ideal series RLC circuit and in a tuned radio frequency receiver (TRF) the Q factor can be written as:

Q=1/R*root (L/C)

Where, R, L and C are respectively the resistance, inductance and capacitance of the tuned circuit

3.2 Circuit Diagram:

The actually consists of heat Transmitter circuit and a Receiver Circuit, with some common components like Capacitor, Resistor, Inductor, Diode and Voltage Regulator.

Diagram of the circuit is shown in Fig.4.

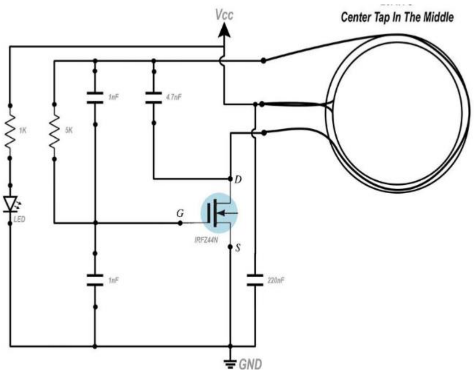

Fig .4(a) Wireless Mobile Charger Diagram (Transmitter)

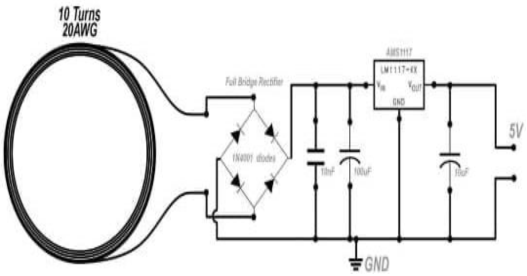

Fig .4(b) Wireless Mobile Charger Diagram (Receiver)

3.3 Working Principle:

This circuit mainly works on the principle of mutual inductance. Power is transferred from transmitter to the receiver wirelessly based on the principle of “inductive coupling”.

Inductance is the property of the conductor, in which the current flowing in a conductor induces a voltage or electromotive force in it or in another nearby conductor. There are two types inductance. **1) Self-inductance, 2) Mutual Inductance.**

“Mutual inductance” is the phenomena in which, when a current carrying conductor is placed near another conductor voltage is induced in that conductor. This is because, as the current is flowing in the conductor, a magnetic flux is induced in it. This induced magnetic flux links with another conductor and this flux induce voltage in the second conductor. Thus two conductors are said to be inductively coupled.

In our Wireless battery charger, we use two circuits. The first circuit is transmitter circuit used to produce voltage wirelessly. The transmitter circuit consists of DC source, oscillator circuit and a transmitter coil. Oscillator circuit consists of one n channel MOSFET IRF540N , two resistors of 1 kiloOhm and four capacitors two of 1nano Farad , one of 4.7 nanoFarad and one of 220 nanoFarad . When DC supply is given to the oscillator circuit, it converts DC power into AC power and an alternating emf is induced in the coil due to the alternating flux in the coil. The operating frequency is determined by using formula $F=1/ [2\pi\sqrt{(LC)}]$.

In the second circuit that is receiver circuit consists of receiver coil, rectifier circuit and regulator. When the receiver coil is placed at a distance near the inductor an alternating emf is induced in the coil due to the flux linkage of the transmitting coil. This is rectified by the rectifier circuit and is regulated to 5V DC using 7805 regulator. The rectifier circuit consists of four 1n4001 diodes and capacitors of 10 nanoFarad, 100 micro Farad and 10 micro Farad. The output of regulator is connected to the mobile.

4. Inductive Power Transfer System Design and Analysis:

4.1 Choice of Series-Series and Parallel-Series Topologies:

The compensation capacitances are chosen independently of the load in primary series compensation topologies, which is useful when the loading profile is changeable. Series-series topology is preferred for variable frequency operation due to its power factor tolerance.

Series-Series topology outperforms parallel-Series topology. As a result, fixed frequency systems prefer the Series-Series structure. However, the Series-Series design has superior efficiency tolerance than the Parallel-Series structure, especially at super-resonant frequencies. Parallel-Series outperforms Series-series for sub-resonant frequencies [7].

The primary and secondary compensating capacitances are chosen based on two criteria:

The second move is secondary capacitance. Secondary leakage inductance and reciprocal inductance are compensated. This correction would increase power transfer to the load. The circuit's overall inductance is used to select the primary capacitance. There are primary capacitances designed to balance only the primary's self-inductance and the circuit's inductance. However, it is desirable to correct the entire circuit for input power factor.

4.2 Series-Series-Topology:

Fig. 5 shows the comparable Series-Series circuit. The analogous circuit's parameters are set.

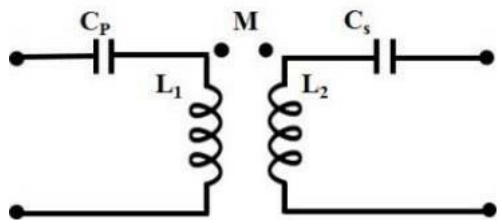

Fig. 5. Series-Series Compensation Network.

4.3 Parallel-Series Topology:

It is possible to recognize in the previous lines one of the greatest

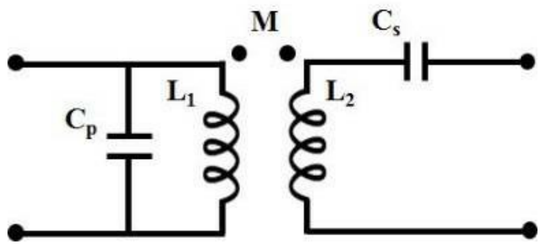

Fig. 6. Parallel-Series Compensation Network.

4.4 Coil Design:

The WPT system has various parameters for finding the ideal coil shape and size. These parameters are: Active power transferred (P_2), Efficiency (η), coefficient of coupling (k), Mutual inductance (M).WPT systems typically use circular or rectangular coils. A strong connection and high misalignment consideration were adopted for this project [9]. It will be positioned beneath the table and beneath the laptop on top of it. This design allows the user to charge their laptop on either side of the table. It's seen in Fig. 7.

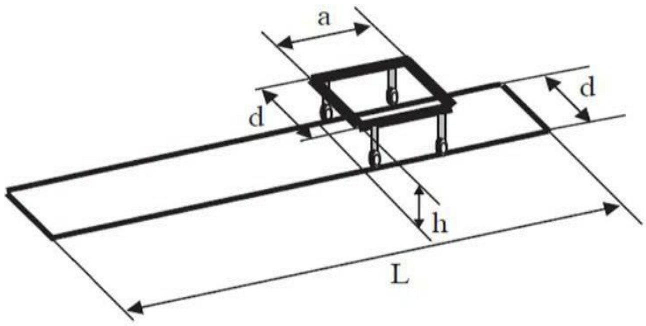

Fig.7. Diagram showing the notation used for the coils.

4.5 Circuit Parameters Calculation:

To calculate L_1, L_2 and M's theoretical inductance, apply the following formulas [1].L_1 is written as;

$$L_1 = \frac{\mu_0}{\pi} N_1^2 (d.\ln\frac{2Ld}{R_1(d+\sqrt{L^2+d^2})}) + \frac{\mu_0}{\pi} N_1^2 \left(L.\ln\frac{2Ld}{R_1(L+\sqrt{L^2+d^2})} - 2\left(d + L - \sqrt{d^2+L^2}\right)\right) + \frac{\mu_0}{4\pi} N_1^2 (L+d) \tag{1}$$

And $L_2$is given by

$$L_2 = \frac{\mu_0}{\pi} N_2^2 (d.\ln\frac{2ad}{R_2(d+\sqrt{a^2+d^2})}) + \frac{\mu_0}{\pi} N_2^2 \left(a.\ln\frac{2ad}{R_2(a+\sqrt{a^2+d^2})} - 2\left(d + a - \sqrt{d^2+a^2}\right)\right) + \frac{\mu_0}{4\pi} N_2^2 (a+d) \tag{2}$$

Where $R_1$and R_2 are the equivalent radius of the windings

$$R_1 = \frac{\sqrt{N_1 S_1}}{\pi} \tag{3}$$

$$R_2 = \frac{\sqrt{N_2 S_2}}{\pi} \tag{4}$$

S_1 and S_2 are the winding radius sections.

The mutual inductance coefficient M is given by

$$M = \; = \frac{\mu_0}{\pi} N_1 N_2 (d.\ln\frac{d+(\sqrt{h^2+d^2})(\sqrt{h^2+a^2})}{d+h\sqrt{h^2+d^2+a^2}}) + \frac{\mu_0}{\pi} N_1 N_2 (a.\ln\frac{a+(\sqrt{h^2+d^2})(\sqrt{h^2+a^2})}{a+h\sqrt{h^2+d^2+a^2}} + \frac{\mu_0}{\pi} N_1 N_2 (2 - \left(h - \sqrt{h^2+d^2-\sqrt{h^2+a^2}-\sqrt{h^2+d^2}+a^2}\right)) \quad (5)$$

In the example of this thesis, where the primary track is longer than the secondary pick up L >> a, the mutual inductance is approximated by

$$M = \frac{\mu_0}{\pi} N_1 N_2 a \, ln(\frac{\sqrt{h^2+d^2}}{h}) \quad (6)$$

A constant value of 4.107 H/m for the permeability of the air

Calculate the resistive values of the windings by

$$R_{es1} = \frac{1}{57} N_1 \frac{2(L+d)}{S_1} \quad (7)$$

$$R_{es2} = \frac{1}{57} N_2 \frac{2(L+d)}{S_2} \quad (8)$$

Calculate the frequency by

$$f = \frac{1}{2\pi\sqrt{LC}} \quad (9)$$

Select capacitors C_1 and C_2 at the secondary resonant frequency. [10].

Calculate the resonant compensation capacitances by

$$C_1 = \frac{1}{\omega^2 L_1}, C_2 = \frac{1}{\omega^2 L_2} \quad (10)$$

The coupling coefficient k [8] determines WPT system performance.

$$k = \frac{M}{\sqrt{L_1 L_2}} \quad (11)$$

The inductive component of the coil is expressed by the quality factor. As a result, the device cannot work at zero phase [9] [10]. The inductor quality factor measures an inductor's perfection and is calculated by

$$Q_1 = \frac{\omega L_1}{Res_1}, Q_2 = \frac{\omega L_2}{Res_2} \quad (12)$$

Where:

$\omega = 2\pi f$

f is the frequency.

L_1, L_2 is the inductance.

Res_1, Res_2 are the wire resistance.

The quality factor of an ideal inductor is unlimited, but all actual inductors have some wire resistance. Solid copper wire has a low resistive value for low frequency designs, but increases with frequency. To avoid the skin effect, utilise Litz-wire, which has low resistance values at high frequencies.

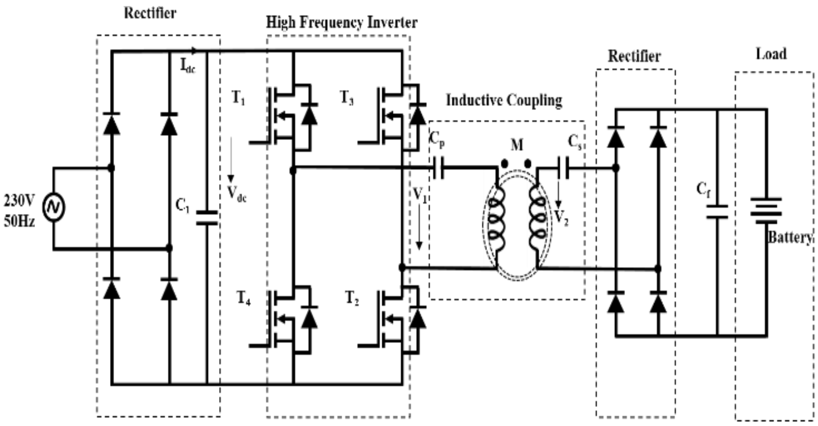

Fig.8. Five components of a wireless power transfer (WPT) system

A/C main with rectifier on primary side, yellow section is inverter. The green area is the primary and secondary compensatory circuits. This diagram shows the secondary rectifier (blue) and the battery load (purple).

This figure illustrates the two phase rectifier's output voltage being converted to 230V AC. The grid and rectifiers will be replaced by a DC power source that can produce the required voltage. Series compensation circuit resonance is the H-bridge inverters' fundamental frequency. Use electricity IGBT inverters.

The transfer coil is located beneath the table, and the pickup is mounted beneath the laptop; the height varies from table to table. The distance between the primary and secondary coils is 3 cm.

4.6 Equivalent circuit analysis of WPT system

Each section of the circuit is translated to its corresponding circuit. These are the same as the V_1 AC voltage source.

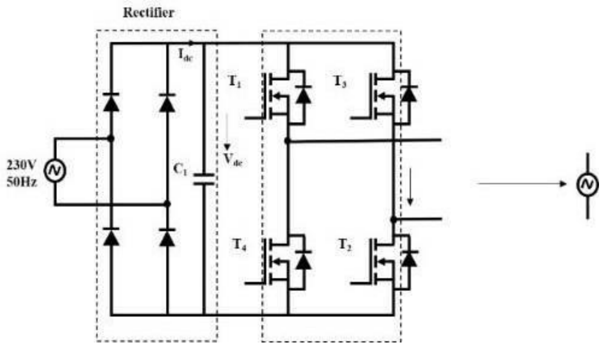

Fig.9. Voltage source equivalent circuit

In the circuit, the inductance M of inductors L_1 and L_2 = 0

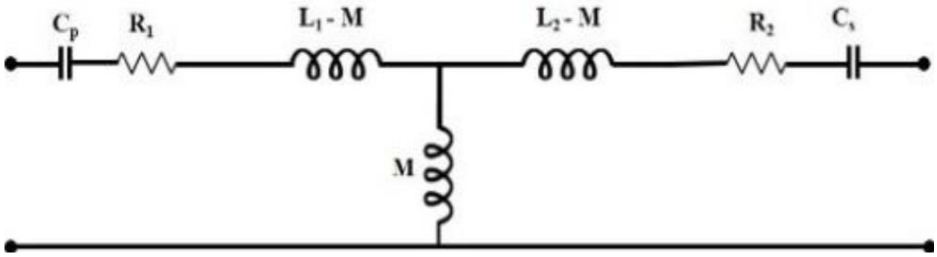

Fig.10. Equivalent circuit of the mutual inductance

In Fig.10 The rectifiers and corresponding load resistance are equivalent to R_L in Fig. 11.

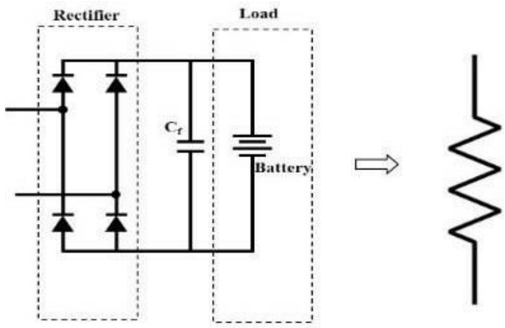

Fig.11. Equivalent circuit of the circuit resistance

As per R_L. Resistive end-load R_L is a laptop or mobile battery.

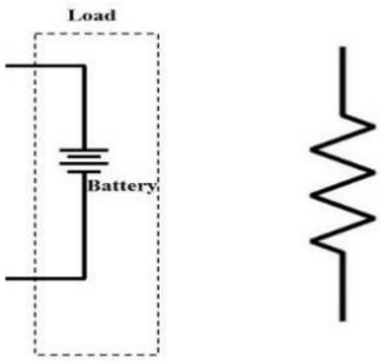

Fig.12. Equivalent circuit of the load resistance R_L

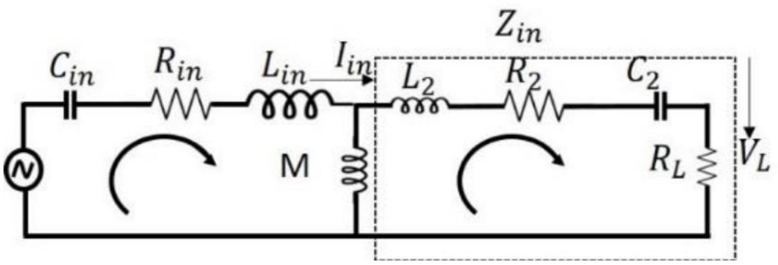

Fig.13. Series-series WPT system equivalent circuit

Based on Figure of WPT system with adjustment, the following equations emerge:

$V_1 = I_1 (\frac{1}{j\omega C_1} + R_1 + \text{jw}L_1) + \text{j}\omega\text{M} (I_1\text{-}I_2)$

$0 = I_2 (\text{jw}L_2 + R_2 + \frac{1}{j\omega C_2} + R_L) + \text{j}\omega\text{M} (I_2\text{-}I_1)$ (13)

The equivalent load resistance in a circuit is determined using the formula

$R_L = \frac{8n^2}{\pi^2} R_{load}$ (14)

n is the number of turns in the primary and secondary coils. $n = \frac{N_1}{N_2}$ (15)

R-Load is the terminal load at DC circuit, calculated by $R_{load} = \frac{V_{load}}{I_{load}}$ (16)

In the analogous circuit all of the quantities are referred to the primary side of the equation.

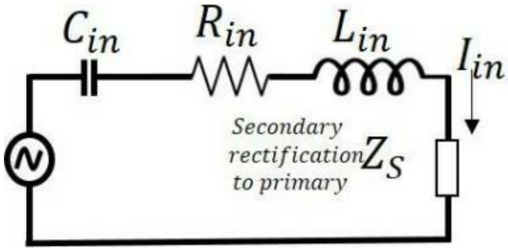

Fig.14. The primary side of a WPT comparable RLC circuit

Voltage V_1 and secondary total impedance Z_2 regulate primary coil current I_1. This is because the primary coil current is series adjusted.

$I_1 = \frac{V_1}{Z_{Total}}$ (17)

Where Z-total is the total primary and secondary impedance and

$Z_{Total} = R_1 + \text{j}\omega L_1 + \frac{1}{j\omega C_1} + \frac{\omega^2 M^2}{Z_2}$ (18)

It is provided by Z_2 (total secondary reflection impedance) to Z_1.

$$Z_2 = R_2 + \frac{1}{j\omega C_2} + j\omega L_2 + R_L \tag{19}$$

By applying (17) in (19), I_1 can be rewritten as

$$I_1 = \frac{V_1}{R_1 + j\omega L_1 + \frac{1}{j\omega C_1} + \frac{\omega^2 M^2}{R_2 + \frac{1}{j\omega C_2 + j\omega L_2 + R_L}}} \tag{20}$$

When the circuit operates at resonant frequency, I_1 equals

$$I_1 = \frac{V_1}{R_1 + \frac{\omega^2 M^2}{R_2 + R_L}} \tag{21}$$

Induced voltage divided by secondary circuit total impedance gives current through second coil

$$I_2 = \frac{j\omega M I_1}{R_2 + \frac{1}{j\omega C_1} + j\omega L_2 + R_L} \tag{22}$$

The secondary coil voltage V_2 is proportional to the primary coil current I_1.

$$V_2 = j\omega M\,(I_1 - I_2)$$

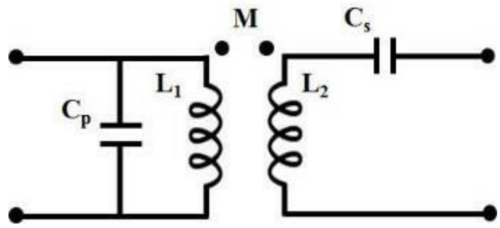

Fig.15. Parallel-series compensation equivalent circuit

The transmitting voltage

$$\overline{V_1} = \overline{I_1} r_1 + jwL_1\overline{I_1} - jwM\overline{I_2} \tag{23}$$

$$jwM\overline{I_1} = jwL_2\overline{I_2} + R_L\overline{I_2} \tag{24}$$

Coil currents sent and received

$$\overline{I_1} = \frac{jwM\overline{I_1}}{jwL_2 + r_2 + R_L} = \frac{jwM\overline{I_1}}{Z_2} \tag{25}$$

Equation Z_2 is the receiving side's impedance. (19) in (23)

$$\overline{V_1} = r_1\overline{I_1} + jwL_1\overline{I_1} + \frac{w^2M^2}{Z_2} \tag{26}$$

Total Coil Impedance (Z_t)

$$Z_t = r_1\overline{I_1} + \mathrm{jw}L_1 + \frac{w^2M^2}{Z_2} \tag{27}$$

Z_r Reflected impedance

$$Z_r = \frac{w^2M^2}{Z_2} \tag{28}$$

Equation (24) and (26)

$$\mathrm{k} = \frac{M}{\sqrt{L_1L_2}} \tag{29}$$

(Since: k=0.1 to 0.5 range)

$$\frac{\overline{I_2}}{\overline{I_1}} = \frac{jwM}{R_L + r_2 + jwL_2} \tag{30}$$

Equation (30) gives optimum inductive power transfer efficiency (31)

$$\eta = \frac{|\overline{I_2}\,|^2R_L}{|\overline{I_2}\,|^2Re\{Z_t\}} = \frac{R_L}{r_1\frac{{L_2}^2}{M^2} + (R_2 + r_2)[1 + \frac{r_1(R_L + r_2)}{w^2 + M^2}}$$

$$P_{L,Max} = \frac{1}{2}\frac{(wMI_1)^2}{wL_2} \tag{31}$$

5. Components used:

Wireless changer Components are : -

5.1 Transmitter Circuit:

1) Voltage Source (5V DC)
2) n-channel MOSFET (IRF540N)
3) Primary Coil (Copper wire) (magnetic polished)
4) Capacitor (4.7nanoFarad, 220 nanoFarad, 1nanoFarad).
5) Resistor (1 kiloOhm)

5.2 Receiver Circuit:

1) Receiver coil
2) Rectifier Circuit - Diode (IN4001), Capacitor (10 nanoFarad, 100 microFarad, 10 microFarad), Resistor (1kiloOhm)
3) Voltage Regulator (7805)

5.3 Other Components:

1) Vero Board.
2) Normal Connecting Wire

6. Specification of the Components:

6.1 Diode:

It allows current to flow easily in one direction, but severely restricts current from flowing in the opposite direction

Diodes are also known as rectifiers because they change alternating current (ac) into pulsating direct current (dc).

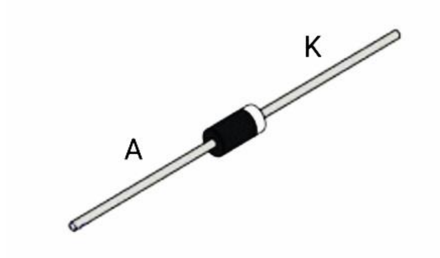

Fig.16 Diode

6.2 Voltage Regulator:

A voltage regulator is a component of the power supply unit that ensures a steady constant voltage supply through all operational conditions. It regulates voltage during power fluctuations and variations in loads. It can regulate ac as well as dc voltages.

Fig.17 Voltage Regulator

6.3 MOSFET:

The MOSFET is the most common type of transistor. In general, it works as a switch, the MOSFET controls the voltage and current flow between the source and the drain.

It is a three-terminal device with gate (G), drain (D) and source (S) terminals. The Fig .18 shows a MOSFET.

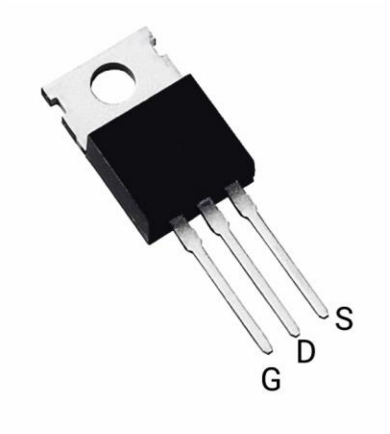

Fig.18 MOSFET

6.4 Capacitor:

A capacitor is a passive electronic component consisting of a pair of conductors separated by a dielectric. When a voltage potential difference exists between the conductors, an electric field is present in the dielectric. This field stores energy and produces a mechanical force between the plates. The effect is greatest between wide, flat, parallel, narrowly separated conductors. Fig .19 shows the pictures of Capacitors.

Fig.19. Capacitor

6.5 Coil:

A coil is a series of loops. A coiled coil is a structure were the coil itself is in turn also looping, one loop of wire is usually referred to as a turn, and a coil consists of one or more turns. Coils are often coated with varnish and/or wrapped with insulating tape to provide additional insulation and secure them in place. Fig.20 shows a picture of coil.

Fig.20 Coil

6.6 Resistor:

A resistor is a two-terminal electronic component designed to oppose an electric current by producing a voltage drop between its terminals in proportion to the current, that is, in accordance with Ohm's law: $V = IR$

The primary characteristics of resistors are their resistance and the power they can dissipate. Other characteristics include temperature coefficient, noise, and inductance. Less well-known is critical resistance, the value below which power dissipation limits the maximum permitted current flow, and above which the limit is applied voltage.

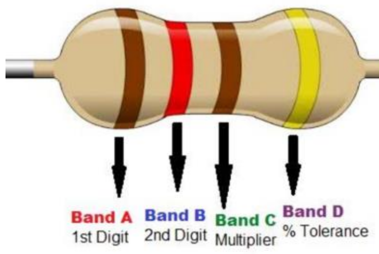

Fig.21 Resistor

7. Simulation of the Circuit:

The simulation of transmitter and receiver circuit are shown and explained below:-

7.1 Transmitter Circuit:

The simulation of Transmitting Circuit is shown in Fig.22. Architectually consists of two resistors, three capacitors, one MOSFET and 20 AWG coil. DC voltage becomes AC voltage in coil. The transmitter coil should be centre tapped.

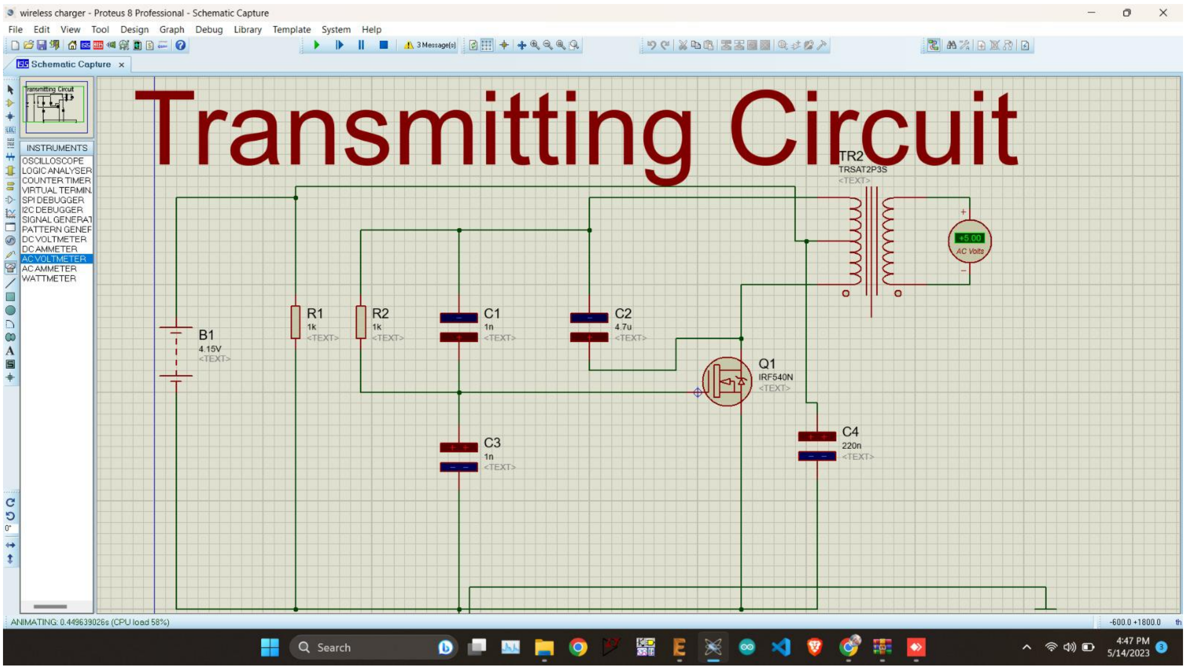

Fig .22 Simulation Diagram of Transmitting Circuit

7.2 Receiver Circuit:

The simulation of receiving circuit is shown in Fig.23.This circuit have a 20 AWG coil, rectifier bridge (consisting of 4 diodes), three capacitors and a voltage regulator. AC voltage from coil converts into DC by the Bridge rectifier circuit. The DC voltage is used to charge mobile phone wirelessly.

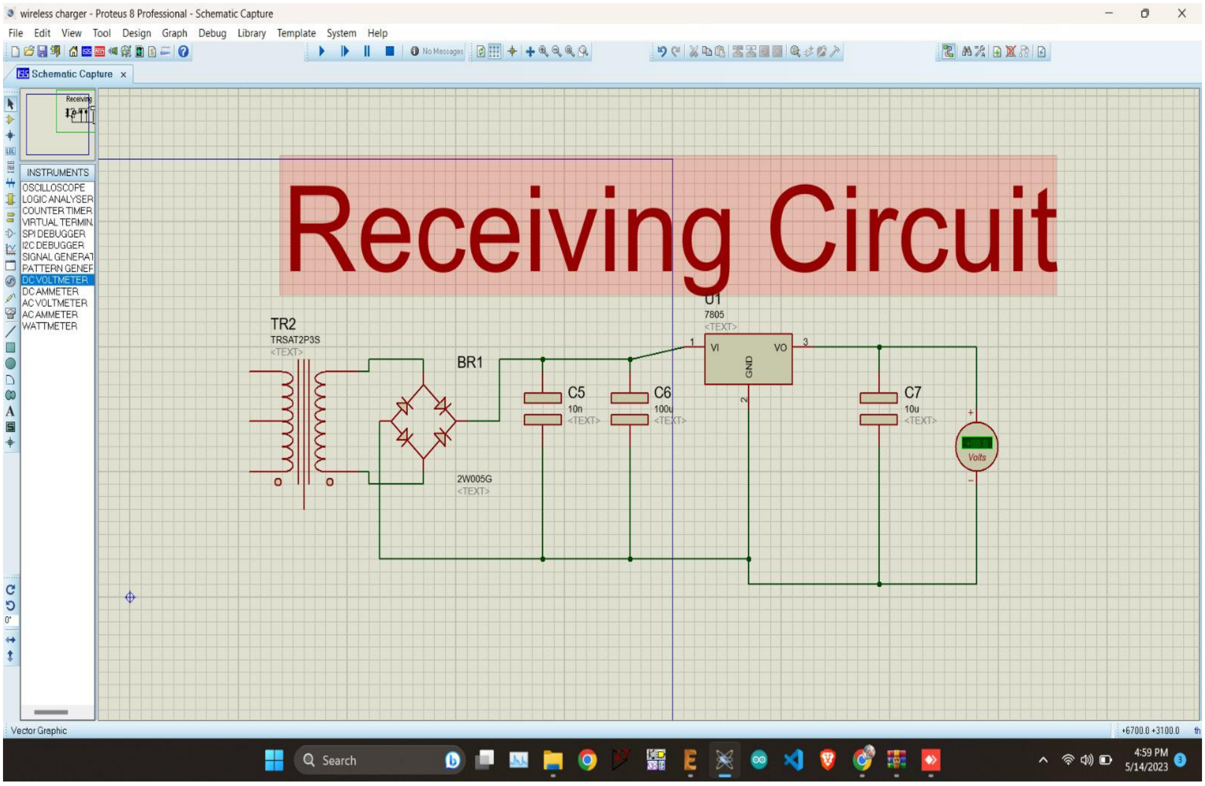

Fig .23 Simulation Diagram of Receiving Circuit

7.3 Overall Circuit:

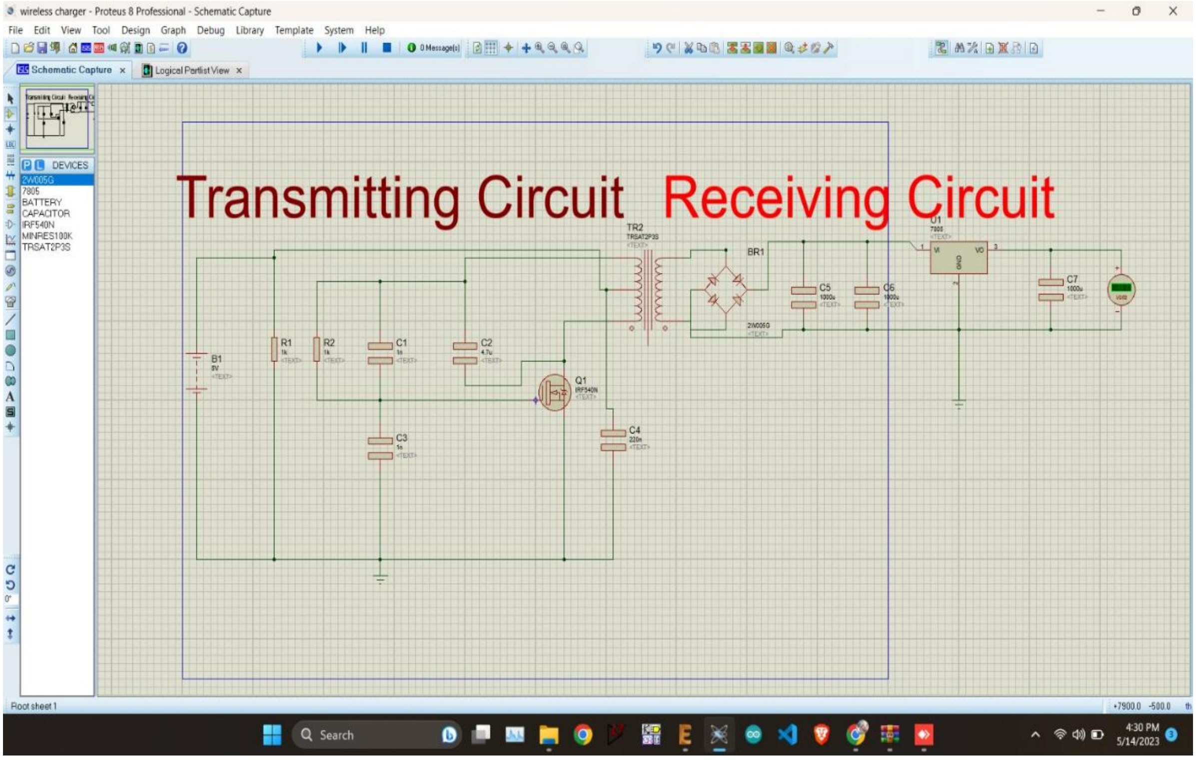

Fig .24 Simulation Diagram of Overall Circuit

8. Hardware Model of the Prototype:

8.1 Hardware Model of Transmitter Circuit:

This is our hardware model of transmitter circuit of our project as shown in Fig.25.

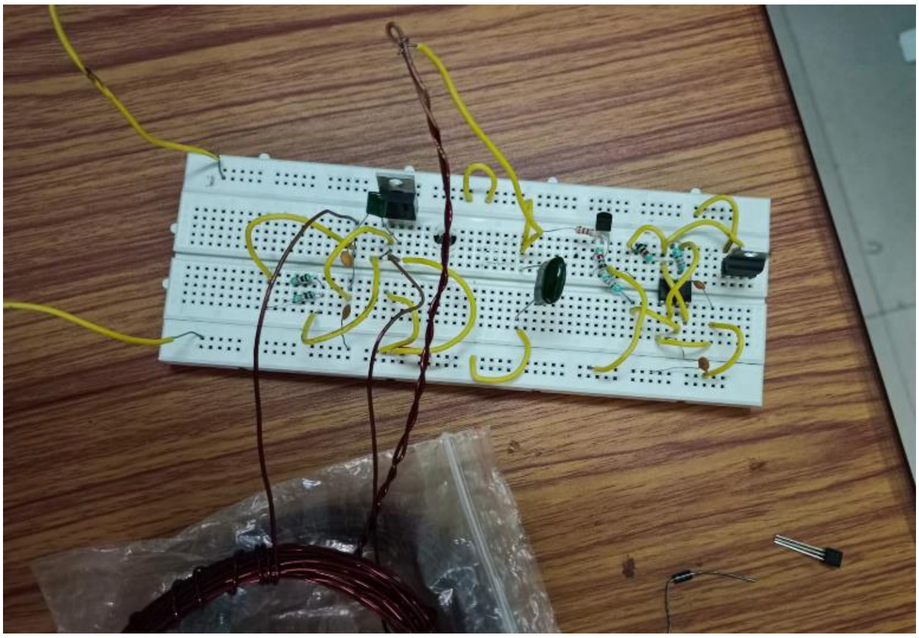

Fig.25 Hardware Model of Transmitter Circuit

8.2 Hardware Model of Receiver Circuit:

This is our hardware model of receiver circuit of our project as shown in Fig 26.

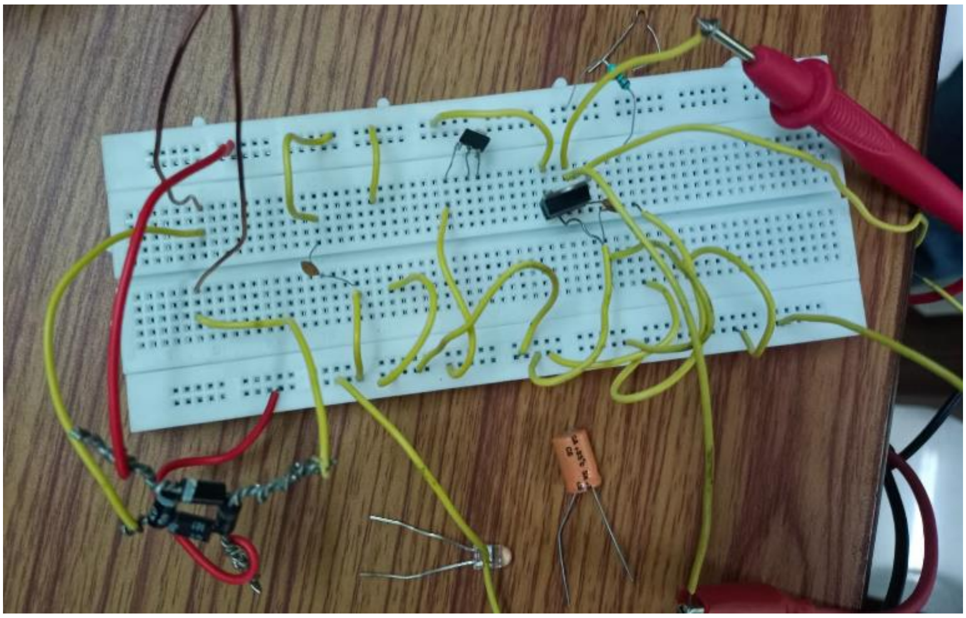

Fig .26 Hardware Model of Receiver Circuit

8.3 Overall Hardware Model:

The total hardware arrangement of this project has been shown in Fig.27 and Fig. 28. The oscilloscope is used to check the output from the receiving coil. The DC source has been connected to give the supply voltage to the transmitter circuit. The arrangements of connections of the mobile phone are also shown in the Figs.

Fig .27 Overall Hardware Model

Fig.28 Overall Hardware Model with Oscilloscope

9. Observation and Results:

It has been observed that the mobile phone is charged wirelessly by this arrangement by the principle of the electromagnetic induction.

Input Voltage (V_{in}) (V)	**Input Current (I_{in}) (Amp)**	**Output Voltage(V_{out}) (V)**	**Output Current (I_{out}) (Amp)**
4.15	0.29	4.9 to 5	0.19

10. Calculations:

Input Power (P_{in}) = Input Voltage (V_{in}) × Input Current (I_{in})
= (4.15 × 0.29) Watt
= 1.2 Watts

Output Power (P_{out}) = Output Voltage (V_{out}) × Output Current (I_{out})
= (4.9 × 0.19) Watt
= 0.93 Watt

Therefore,

$$\text{Efficiency } (\eta) = \frac{Output\ Power\ (P_{out})}{Input\ Power\ (P_{in})} \times 100\%$$

$$= \frac{0.93}{1.2} \times 100\%$$

$$= 0.775 \times 100\%$$

$$= 77.5\%$$

11. Conclusion:

Wireless battery charging has many advantages in terms of convenience because users simply need to place the device requiring power onto a mat or other surface to allow the wireless charging to take place anywhere, anytime. No need to untangle cords or find the right connector. Fewer cords mean less electrical faults. Most wireless chargers are smart which means they can automatically turn off once devices are fully charged to stop overheating. The contribution in this work will benefit society in terms of convenience, reduced wear of plugs and sockets. The proposed model can also be used in medical applications. One of the key challenges of the wireless battery charging system is the reduced efficiency due to the resistive losses on the coil. This systems also work for very short distances only. To use it for long distances, the number of inductor turns should be high which in turn increases resistive power losses.

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