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Wireless Power Transmission Circuit for Mobile Phone Charging

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Abstract:- This paper describes the wireless power transmission for charging of mobile phone. In this paper, transmitter section and receiver section are described. In transmitter section, power supply, transmitting coil, controller and LCD (Liquid Crystal Display) to show simulation result. Receiving coil, regulator and output load are included in receiver section. The output voltage of power supply in transmitter section is fed to transmitter coil and also supplied the controller after through regulator. The controller (Ariduno Uno) controls the input voltage of transmitting coil by sending PWM (Pulse Width Modulation) to the MOSFET (IRFZ44N). The output voltage of the filter is connected to the one end of the transmitter coil to resonate the coil at particular frequency 500 KHz to 1000 KHz. Proteus Design Suite software has been used for simulation in the transmitter circuit.

Keywords:- *transmitting coil; receiving coil; magnetic field induction.*

I. INTRODUCTION

The growing in utilization of this system is battery powered and regularly recharged; usually by connection they power cord. The conventional wire system creates a mess when it comes to charging several devices simultaneously. It also takes up a lot of electric sockets and not to mention the fact that each device has its own design for the charging port. Wireless power transmission is from one point to another through vacuum or an atmosphere without the use of wire or any other substance. This can be used for applications where either a continuous delivery of energy is needed, but where conventional wires are unaffordable, inconvenient, expensive, hazardous, unwanted or impossible. Fig. 1.shows the block diagram for wireless power transmission.

The power can be transmitted using inductive coupling for short range, resonant induction for mid-range and electromagnetic wave power transfer for high range. Wireless power transmission is a technology that can transport power to locations, which are otherwise not possible or impractical to reach. In smart phone battery lives are short, it is unavoidable that the user can stand up to a certain in which a critical job such as doing an emergency call, sending an urgent email or receiving contact information in the mobile may not be carried out.

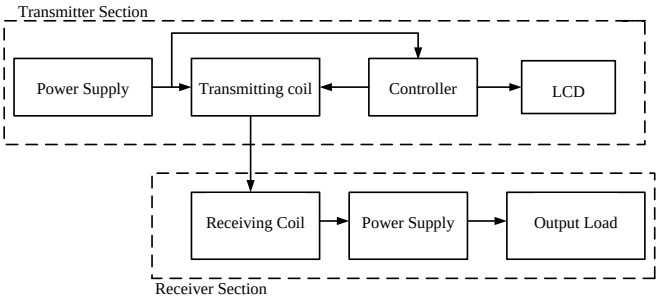

Fig 1:- Overall block diagram of the system

II. DESIGN CONSIDERATION

A. System Concept

The system design of wireless charging is to develop and implement the charging type. As the name implies wireless charging, wireless technology plays an important role in this paper. Resonant inductive coupling or electro-dynamic induction is the near field wireless transmission of electrical energy between two magnetically couples coils that are part of resonant circuits tuned to resonate at the same frequency to resonate at a particular frequency using a capacitor. The inductance of the coil usually should have from 5mH to 20mH. To get the required inductance use the air core coil which are made up of 0.1mm diameter copper wires.

The input voltage of transmitter coil is controlled by controller by sending the pulse to the transistor depending upon the output voltage of the voltage-divider. Voltage divider is used to sense the input voltage of transmitter coil. The output voltage of the filter is connected to the one end of the transmitter coil to resonate the coil at particular frequency. Another end of the transmitter coil passes through the IRFZ44N and grounded with the resistor.

B. Transmitter Design

In transmitter section, 220 to 24V step-down transformer, filter and regulator are included. Power supply is designed to give 12V DC. To maintain the 12V regulation, input voltage regulator must be approximately 2.5 V above the 12 V. So, 24V step-down transformer is used to give the output through capacitor. Regulator is used to regulate 12V output and supply the controller with voltage divider. Filter circuit design is shown in Fig. 2.

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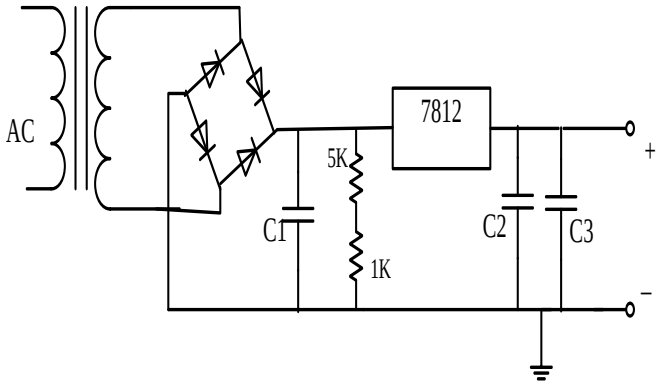

Fig 2:- Filter circuit design

C. Receiver Design

Receiver circuit is designed to produce 5V USB output. To reduce current losses in 5V regulation, linear voltage regulator LM7805 is used. LED is used with a resistor to show the power available at the USB. Design of receiver circuit is expressed in Fig. 3.

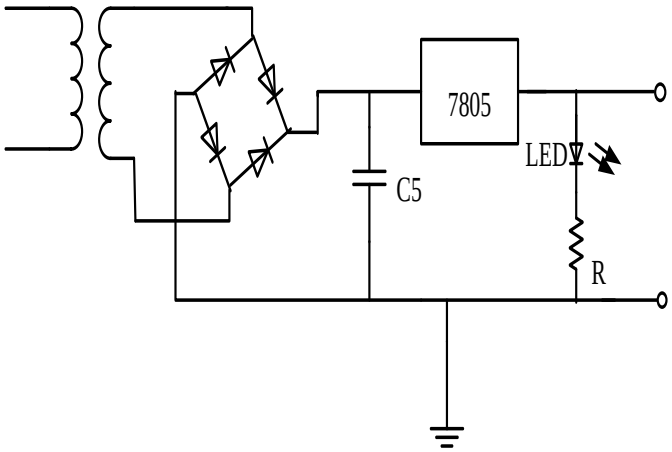

Fig 3:- Receiver circuit design

III. DESIGN CALCULATION

To charge the electronic devices wirelessly, 5V output is targeted with suitable ampere. According to the tests and results, the circuit produces 5V and 150mA output to charge battery. The output current depends on the current gained by the receiver coil from the transmitter coil. So, the output current varies from 120mA to 180 mA according to the distance between the two coils and it also depends upon the inductance of two coils. To reduce the charging time the output current should be much. The output current can be extended by using regulator. But the source current (the second coil receives current) is too small to extend.

A. Filter Design

The input voltage regulator must be approximately 2.5V above the output to maintain regulation.

So, 7812 regulator, V_{DC} = 14.5 V

$f_{full\text{-}wave}$ = 100 Hz

$V_{out(transformer)}$ = 24V

$V_{(rectifier)}$ =1.4V

$V_{P(rect)}$ = 1.414×24 -1.4 = 32.536 V

Resistance for 7812 regulator, R_L = 12V/1A = 12 Ohm

$$V_{DC} = (1 - \frac{1}{2fR_LC})V_P$$

So, C_1 = 750 uF~1000 µF (50V)

.

B. Induction Coil Design

The inductance and capacitance for both resonating coils are the same. The combination of number of turns and diameter determine the inductance. Coil inductance is the best between 5mH and 20mH. So, select inductance of the loop as 10mH. To get the required inductance, the coils are systematically flat.

Inductance of the loop =10mH

Loop diameter , D = 60 mm

Wire diameter, d = 0.1 mm

Relative permeability , μ_r =1

$$L_{loop} = N^2 \mu_0 \mu_r (\frac{D}{2}) \times (\ln(\frac{8D}{2}) - 2) \quad (2)$$

Number of turns = 8 turns

C. Receiver Circuit Design

Receiver circuit is designed to produce 5V USB output. To reduce current losses in 5V regulation, linear voltage regulator LM7805 is used. LED is used with a resistor to show the power available at the USB.

$V_{p(in)} = \sqrt{2}\, V_{rms} - 1.4$

$V_{p(in)}$ =5.47×1.414−1.4=6.33V

Let ripple factor, r =0.01, R=680Ω

$$V_{DC} = (1 - \frac{1}{2fR_LC}) \times V_P(in) \quad (3)$$

$$V_r = \frac{V_{P(in)}}{fR_LC} \quad (4)$$

$$r = \frac{V_r}{V_{DC}} \quad (5)$$

$V_r = 0.01 \times V_{DC}$

$$\frac{V_{P(in)}}{fR_LC} = 0.01 \times (1 - \frac{1}{2fR_LC}) \times V_P(in)$$

$$\frac{1}{2fR_LC} = 0.01 \times (1 - \frac{1}{2fR_LC})$$

C_5=1477 µF

Thus, select C_5=1000 µF (25V)

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IV. SYSTEM OPERATION AND RESULTS

The output current depends on the current gained by the receiver coil from the transmitter coil. So, the output current varies from 120mA to 180 mA according to the distance between the two coils and it also depends upon the inductance of two coils. The system uses the inductive coupling to charge 5V battery. The wireless power charging has two sections; transmitter and receiver. In transmitter, circuit is designed to provide required voltage and current to the transmitter coil. As the current flow through the transmitter coil, magnetic field is generated to drive both transmitter and receiver coil. The voltage and current in the transmitter coil are controlled by crocontroller by generating pulse width modulation (PWM) through MOSFET.

A. Simulation Result

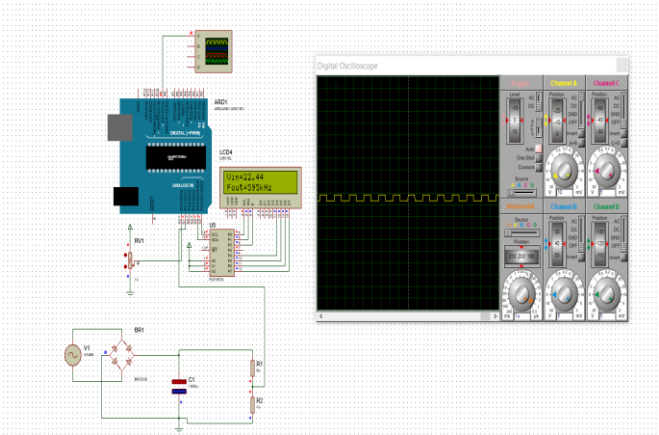

Fig 4:- Simulation of transmitter coil input voltage

Before fabricating the circuit, the transmitter circuit must undergo simulation. The simulation process is using the Proteus Software and shown in Fig. 4. The result is shown the output voltage and frequency of transmitter circuit.

B. Testing

The output voltage of the overall circuit is 5V. Testing the output voltage is shown in Fig. 5. To get 5V, voltage regulator 7805 is used for the reason of the minimum current losses.

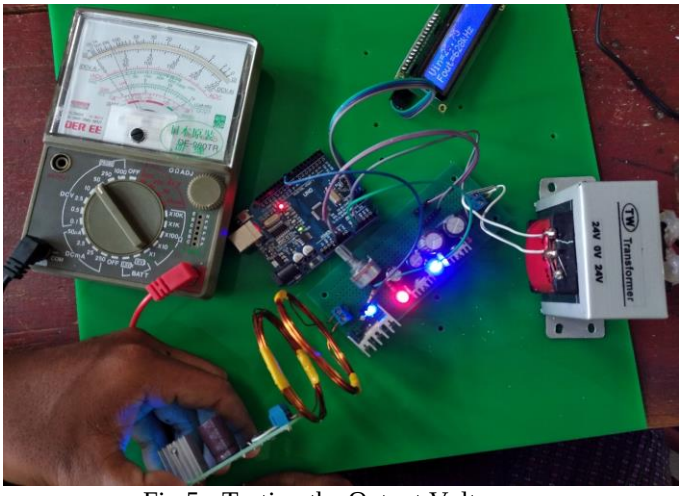

Fig 5:- Testing the Output Voltage

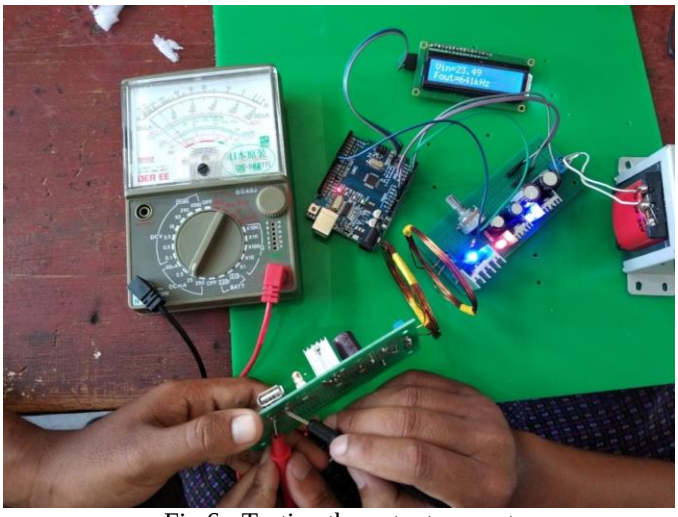

Fig 6:- Testing the output current

The output current is average 150 mA, it varies from 120 mA to180mA according to the inductance of the coil or distance between transmitter and receiver coil. Testing USB output current is shown in Fig. 6.

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