Wireless Charging from Direct Current Source using Magnetic Resonance

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ABSTRACT

This research presents a wireless AC-to-DC low power transfer over a distance. The distance of remotely located targets from the transmitter coil and receiver coil which has the load is the major concern in these applications. The transmitter and receiver circuits are constructed. Two inductively coupled coils are designed and used in both transmitter and receiver sections. Through experiments, it was observed that with such a design, the power transfer has a limited range, and the range will be smaller for smaller receiving coils and improper alignment. It was also observed that the output voltage increased correspondingly with an increasing number of turns and coil diameter and good output voltage is harvested with the optimized transmitter circuit resistance 340 Ω and is 12 VDC. Experiment results showed that the system could transmit at a distance of 35inches with an output load voltage of 3 VDC.

Keywords: Wireless power transfer, Transmitter, Receiver Coil,, Magnetic resonance

1. INTRODUCTION

Smartphones are changing the way people live their lives today and have become a large part of our culture. For most users, it is such a hassle when their mobile phones are getting off, notifying them that they need to connect their charger before it shuts down. Wireless charging can perhaps eliminate the problem.

The technology and theory behind wireless charging have been around for a long time. In the year 1899, Nikola Tesla was the first inventor who conducted an experiment on transferring electricity wirelessly.

Wireless charging devices that are being launched today, by different phone brands, work by transferring energy from the charger to a receiver at the back of the phone via electromagnetic induction. The transmitter-generated electromagnetic field is low and power ineffective, functioning even over short distances [1].

Besides inductive charging, there is another kind of wireless charging, the use of magnetic resonance technology. Similar to the former technology, magnetic resonance could possibly charge the product at a range and charge more than one gadget at a moment. The scalable power output that possibly fulfills various electronic device applications is the perfect solution [2] controversial issue, as saving wires results to security and convenience improvements. The magnetic resonance coupling is a main study method for Wireless Power Transfer. It can work in high efficiency on large air gaps [3].

The challenge is to develop a wireless charging system from a direct current source by means of magnetic resonance concept. Specifically, the project is for smartphones to charge at a distance of more or less one meter.

One of the issues in the wireless power transfer is its effect on people's health. The International Commission on Non-Ionizing Protection (ICNIRP) discovered that no conclusive proof of negative effects on people's health when subject to inductive charging- a tiny electromagnetic field across transmitter [1]. The average induction charger generates a field which is no more harmful than electromagnetic waves. The original simulations of Tesla, an impact called Resonant Inductive Coupling enabled the creator to transmit power securely for several meters [4].

The inductive and capacitive coupling transfer power to a receiver from a very near transmitter. Its location in the near field for which antenna distance is much less than one wavelength and non-radiative and independent of each other are the oscillating magnetic and electrical fields [2]. The receiver and transmitter coils require closer alignment with inductive technology, leading in wireless power transfer being used efficiently. With resonant technology, there is no need for close coupling of the receiver and transmitter coils and the placement of the receiver on the charger can provide a higher degree of flexibility [5].

Similar to the first generation of inductive charging technology is similar to magnetic resonance in providing significant customer advantages. Magnetic resonance can charge products at a range and can charge more than one device at a moment, logically [6].

Objectives of the study

The project aims to develop a wireless charger from direct current source using magnetic resonance. Specifically, this aims to develop a wireless power transfer at a maximum distance as possible using a fixed direct current source.

2. MATERIALS AND METHODS

Design stage

The researchers used block diagram in the conceptualization of the design project.

Figure 1 shows the flow of the system from the input or DC power source to the output or load. The wireless transmission took place between transmitter coil and receiver coil.

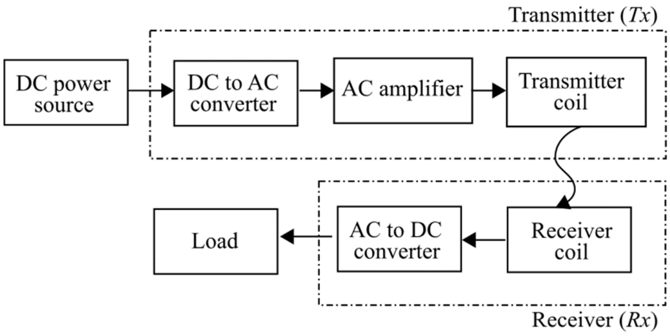

Figure 1. Block diagram of the system.

Development stage

Researchers were able to identify the components needed in the circuitry for both the transmitter and receiver. Figure 2 shows the transmitter (*Tx*) circuit R1, R2 and C1. The transmitter coil is a variable in the transmitter circuit and subject to a test to determine the better values for the greater distance. This is to transmit a usable power given the certain DC power source.

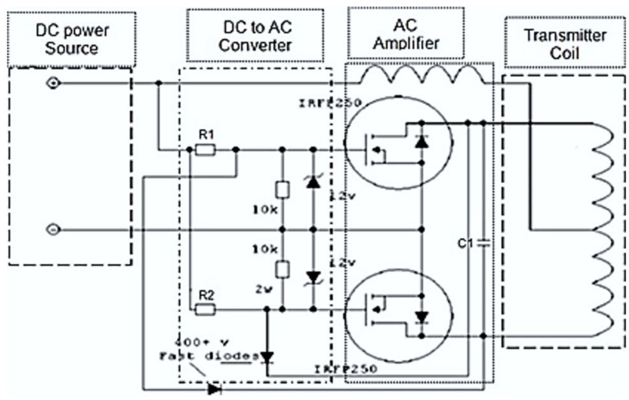

Figure 2. Transmitter (*Tx*) circuit configuration.

The circuits were constructed according to the circuit shown in Figures 1 and 2. The configurations of circuits are summarized in Table 1. The distance between Tx and Rx was manually adjusted and measured using the standard measuring tool. Multi-tester was used to measure the output voltages of the receiver during the experiment. It was recorded and subject for comparison.

The full bridge rectifier has been used in the AC to DC converter as shown in Figure 3. The coil is a variable to determine the better size and number of turns and diameter for a better output.

Table 1. Summary of the configuration of the three different set-ups.

Set-up	Number of Turns		Diameter	
	Tx Coil	*Rx Coil*	*Tx Coil*	*Rx Coil*
A	20	10	9	6
B	40	20	9	9
C	80	40	10	7

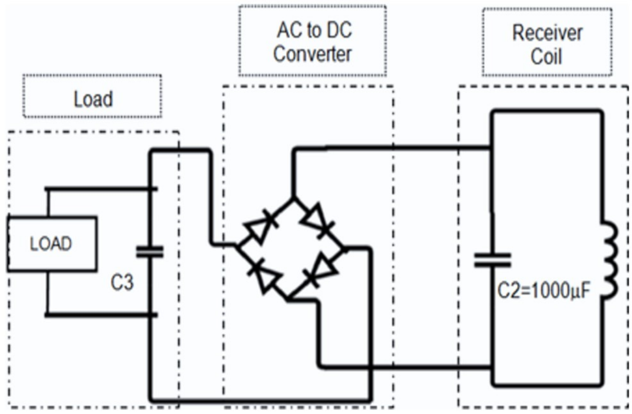

Figure 3. Receiver (*Rx*) circuit configuration.

Testing and Evaluation Stage

Trial and error method were used to determine the best values for the distance of *Tx* to *Rx*. [7],[8]. The method was done in setting up the number of turns of coils in both *Tx* and *Rx* as well as the different diameters of coils for both *Tx* and *Rx*. Testing the different set ups until getting the best result.

3. RESULTS AND DISCUSSION

Several set-ups and values for variables have been utilized on the system. Those with significant results were recorded and tallied on Table 2.

Table 2. Distance between *Tx* and *Rx* and output voltage obtained in different set-ups.

Set-up	Number of turns		Diameter (inches)		Distance between *Tx and Rx*	Output voltage in *Rx*
	(Tx)	*(Rx)*	*(Tx)*	*(Rx)*	(inches)	(Vdc)
A	20	10	9	6	9.5	1.5
B	40	20	9	9	15	1.5
C	80	40	10	7	35	3

Set-up A got a maximum distance of 9.5 inches having the maximum output voltage in Rx which is 1.5 Vdc. So as the output of Set-up B, but with a number of copper wire turns on both Tx and Rx. Set-up C has the larger values and evidently has the larger output voltage but with small diameters for both Tx and Rx. For the common components, the power source used is 12 VDC 9AH, the wire size is 22 mm, and for the common components of Tx, the capacitors are 0.0022 µF (Mylar) and 1µF250V (electrolytic), and a 340 ohms resistor.

Based on the recorded values, it has been observed that the number of turns of the copper wire in the coil and its diameter both for the transmitter and receiver are directly proportional. Values of the distance and output voltage were also relative.

Among the three set ups, Set up C showed the most outstanding performance. It is evident on the result that the set objectives of the researchers has been met, i.e. a 35-inch distance between Tx and Rx, achieving 80 turns of copper wire at 10 inches diameter of the Tx coil and 40 turns of copper wire at 7 inches diameter of the Rx coil.

The result proves the myth about magnetic resonance [6] that power could be transmitted in range. Researchers have not tested its possibility yet, but it was recommended in next study.

The system utilizing various variables shows the capacity of charging a device with a distance of 35 inches with 3Vdc output. The coil's number of turns and diameter both for Tx and Rx are the main factors in setting up a wireless power transmission. Further experiment is necessary to measure the magnetic field and to upgrade the covered distance of the system with a low input voltage.

4. CONCLUSIONS

The designed project showed that the development of wireless chargers from direct current (DC) source with the use of magnetic resonance is possible. The two coils – transmitter and receiver coils allow the wireless power transmission to happen. Both generates magnetic fields and signals which are significant in charging activities.

The use of multiple receivers to test the effectivity of the system to charge multiple devices is not yet proven by the researchers. Measuring the maximum distance with fix source has to be established also. Further researches on these matters were recommended.

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