Design and Implementation of a Wireless Power Transfer Network

Abbas Saleh Hassan¹, Raoof Talal Hussein¹, Izz Kadhum Abboud¹

¹Al-Mustansiriya University / faculty of Engineering/ Computer Eng. department

*Abassalmhyawy@uomustansiriya.edu.iq

Abstract. Wireless power transfer depends on some scientific methods such as a ringing and electromagnetic. This idea developed to transfer power to distance more than other methods that used a magnetic field. This development leads in inventing wirelessly charging devices that may be used for example in mobile charging. The main objective of this paper is to design a circuit that has a transmitter and receiver worked at the same frequency, and used for wireless power transmitting. For this to be done the transmitter and receiver coils need to be the same, capacitors may be vary depending on the application type.

1. Introduction

Wireless power transfer (WPT) or electromagnetic power transfer is the act of transfer of electrical energy without a physical connection such as wires. WPT system sender works on electrical power which take from the source, creates an electromagnetic field, and sends power via space to the receiver, while the receiver take the power from the field and send it to the load device. WPT advantage is that it can reduce the use of the batteries and wires, so increasing the portability and make it safer for the working environment of any electronic device. WPT is useful when the connecting wires are not easy to connect or hazard to power the electrical devices such as from children and so on. WPT can be divided into two fields, near and far-field [1].

Near Field type also called inductive Coupling which is a wireless transfer of the energy depends on electromagnetic field, using Maxwell laws, the most important aspect in the near field type is the variation of the magnetic field that effect voltage in a secondary side. This type of transfer is used in a warehouse applications and automobile production to provide remote robotic and vehicles with power [2]. When a low frequency (such as 85 kHz) used, it can transfer higher power levels which may be used in vehicle charging applications. Although inductive coupling systems transfer wireless power in a shorter range than the far field systems, their total effectiveness and power levels are higher [3]. Far-field type is mean that the electrical load is far from the source. This type need a line of sight and a high power to work, it may be divided into two groups, which are the laser and the microwave [4].

2. Wireless Power Transmission Techniques

Several methods WPT are studied and experimented. This section describes briefly these methods.

2.1 Microwaves Wireless Power Transmission

Microwave WPT is a technique used to transfer power for a long distance. In this technique a microwave source of voltage is used, this source can generate and send the microwaves. Microwave receiver also...
needed and is connected with the load so it can receive the microwave from the source then converted it to an electrical energy used to feed the load.

2.2 Laser Wireless Power Transmission
The second type is by using laser beam move from the source to destination across a specific distance; this method depends on the intensity of the laser beam and can range for small distance. The receiver use photo voltaic cells to energize the laser beam and it to electrical energy.

2.3 Magnetic Resonance Wireless Power Transmission
The main aspect of magnetic resonance is that if there are two coils have an inductive coupling between them, this mean that if there is a varying current in one of coils then there is a magnetic field near this coil and will interact with the second coil which can convert it back to a current as a destination. This magnetic resonance operates on the same frequency between two coils [5].

3. Applications of Wireless Power Transmission
- Electrical vehicles wireless charging.
- Portable devices wireless charging.
- Wirelessly charging of transports.

A suggested Future application of WPT technology may be includes:
- Wireless powered homes.
- Electrical vehicles on road wireless charging.
- Solar Power Satellite
- Wireless power smart city.
- Wireless controller for extinguish the fire.
- Wireless powered train [6].

4. Related work
Many researchers work in WPT using different methods for different applications such as:
Reference [7] suggest how to emit electrical power using solar energy with a low scale, the inductive coupling utilized as an antenna to emit power wirelessly through it. Reference [8] focused on studying both solar and wireless technologies. Mainly give attention on producing efficient and clean power transmission through wireless methods; this will lead to a great development in the solar and wireless technologies. Reference [9] introduced a good way for the inductive coils selection and designs. It explained a suggested method to implement a low cost and power inductive system used for charging Li-ion batteries in biomedical devices. Reference [10] explained the on road Electric Vehicles and the Online Electric Vehicles. These vehicles can develop the transport system. The Solar Power Satellite which aims to transmitting the solar energy is done.

5. Aim of work
The goal of this paper is to develop a (WPT) system and implement it. The main steps of this work are to study the wireless electricity transfer technologies, review it, and evaluate available solutions. The major objective is also to design a printed circuit boards (PCBs), assemble, test, and develop it. The system consists of a transmitter and receiver boards; it uses the inductive coupling method to transfer electricity wirelessly.

6. Circuit Basic components
Power MOSFETs provides good manipulating techniques to accomplish low on-resistance. This advantage additionally to quick switching gives the designer a reliable and efficient component for use in a large number of fields.
TO-220 is widely used for all industrial applications at power scattering levels to about 49.8 watts. The thermal resistance with low value and price of the TO-220 leads to its large usage through the business. See Fig.1. [11]

![Power MOSFET](image)

**Figure (1): Power MOSFET**

7. **System Implementation**

The proposed system was implemented in two different methods which are: simulation on multisim, and hardware circuit building.

7.1 **Simulation on Multisim**

To implement the circuit two programs were used which are: multisim and electronics workbench. At the beginning of the implementation the circuits shown in Fig.2 and Fig.3 which consists of the main parts of the transmitter and receiver were implemented within the multisim program.

The required results will not be found within the AC as shown in Fig.4, while the results of the DC is shown as in Fig.5 but not suitable, so the result of this circuit is not appropriate to initiate practical implementation.

For this reason, some modifications are required to obtain a suitable electric circuit that gives the required results shown in Fig.6 and the implementation of the multisim as shown in Fig.7.

![Main component circuit](image)

**Figure (2): Main component circuit**
Figure (3): Main component circuit in multisim.

Figure (4): Result of AC

Figure (5): Result of DC
Figure (6): the final circuit

Figure (7): the final circuit in multisim

- Multisim results

After implementing the circuit shown in Fig. 7 and make some simple changes such as adding some devices show in Fig.8 to measure the following measurements:
  - Voltage measurement of the circuit show in Fig. 9.
  - The final transmitter voltage shown in Fig. 10.
  - The total transmitter current to shown in Fig. 11.
  - The total frequency of the transmitter is also shown in Fig. 12.

Figure (8): Add devices to measurement
Figure (9): Measuring of the voltage

Figure (10) Measuring of transmitter voltage

Figure (11) the total transmitter current
7.2 Hardware circuit implementation
The circuit as shown before consists of a number of electronic components which are specified by table 1:

| Component type | values    | Number |
|----------------|-----------|--------|
| Resistance     | 10 k ohm  | 2      |
|                | 1000 ohm  | 1      |
|                | 100 ohm   | 4      |
| Capacitor      | 100 nF    | 2      |
|                | 6.8 uF    | 8      |
| Diode          | 1N4148    | 2      |
| Transistor     | IRFZ44N   | 2      |
| Inductive      | 100uH     | 2      |

Fig.13 is showing a DC power supply that converts the voltage from the 220 V to 12V.
Next, the circuit is activated, The LED operates, this means that the circuit is operating correctly as shown in the Fig. 14, finally the circuit was built on a printed circuit board as show in Fig.15.

![Figure (14) Circuit operation](image1)

![Figure (15) the printed circuit board](image2)

8. The results and discussions

From the overall study of WPT important points may be noted:

1) As a result, if the space is close, the transfer will be of high voltage.
2) The space of the power that can be transmitted is up to 4.96 cm with 3.84 Volt,
3) The WPT isn't influenced by protecting materials, for example, the nearness of books, woods, and hands.
4) As a result, WPT can be used for small devices charging, such as mobile.
5) As a comparison with the reference[12], it use a strongly coupled magnetic resonance (SCMR), in this circuit the author use a inductive and capacitor circuits to transfer power and concludes that the use some electronic components may has a great challenge for example, the rectifier, MOSFET driver, While in our research the MOSFET was used in the circuit.
9. Conclusion
WPT will change our life on many different applications such as in charging a handheld device, charging car, and heating or warming. The warming is done by using WPT through microwave transfer from space to earth to supply us with power. WPT through resonance and inductive coupling leads in rapid development in the capabilities of most small electronics such as cell phones, and PDAs.

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