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Design of Simultaneous Wireless Power Transfer System to Multiple Loads

R. Narayanamoorthi*, A. Vimala Juliet* and K. Vijayakumar*

Abstract: This paper presents an idea to eradicate the hazardous usage of electrical wires which involve lot of confusion in particularly organizing them. It uses the techniques of transmitting power without using wires with an efficiency with non-radiative methods. In the multiple load environment simultaneous charging plays a vital role for the coil design. Single transmitter and multiple receiver is utilized and tested experimentally for different coil turns and distance. Based on the results we can design an efficient multiple load system by changing the number of coil turns and size of the transmitter coil.

Keywords: Multiple Load, Resonant Coil, Single transmitter.

1. INTRODUCTION

Inductive coupling is a conventional method to realize the near-field wireless power transfer (WPT) for short-range applications up to a couple of centimeters [1]. Recently, magnetic resonant coupling has drawn major interests for implementing the near-field WPT due to its high power transfer efficiency for applications requiring longer distances, say, few centimeters to several meters [2]. The transmitter and the receiver in an WPT system are designed to have the same natural frequency as the system's operating frequency, thereby greatly reducing the total reactive power consumption in the system and achieving high power transfer efficiency over long distances.The WPT system with a single pair of transmitter and receiver has been extensively studied in the literature for e.g. maximizing the end-to-end power transfer efficiency or the power delivered to the receiver with a given input power constraint [3]-[5]. However, there is limited work on analyzing the WPT system under the general setup with multiple transmitters and/or receivers. The system with two transmitters and a single receiver or a single transmitter and two receivers has been studied in, while their analytical results cannot be applied for a system with more than two transmitters/ receivers [6].In this project we consider a point-to-multipoint MRC-WPT system, where one transmitter connected to a stable energy source sends wireless power simultaneously to a set of distributed receivers, each of which is connected to a given load. We extend the results in to derive closed-form expressions of the transmit power drawn from the energy source and the power delivered to each load, in terms of various parameters in the system [7]. Our results reveal a near-far fairness issue in the case of multiuser wireless power transmission, similar to its counterpart in wireless communication [8]. Particularly, a receiver that is far away from the transmitter and thus has a small mutual inductance with the transmitter generally receives lower power as compared to a receiver that is close to the transmitter.

2. EXPERIMENTAL ANALYSIS

WPTS has been tested by using CRO. In the CRO the transmitter and multiple receiver output is connected one by one and take the reading correspondingly.

Step by step procedure for testing the WPTS

- Give the proper AC incoming voltage (230) to the transformer 1 and transformer 2 as well CRO unit
- From the transformer 1 output voltage 5V rectified and given to the controller unit

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- From the transformer 2 output voltage 12V rectified and given to the controller unit
- From the driver circuit the output voltage connected to transmitter unit side
- Receiver unit, 25 turns, 30 turns, 50 turns kept in triangle direction with some distance

As per this project we could able test the different height from the 0 to 70 mm. During this testing the output voltages were varying depends upon the distances fixed.

A. Tx& Rx Placed at 10 mm Distance

During testing of WPTS at small distance at 10 mm the Output voltages almost 80% to 90% is getting at receiving at receiver side. But there is voltage has been varied with in these three receiver coils. Because three coils are having different number turns. The maximum number of coils(50turns) is getting high voltage and minimum number of coils (25turns) is getting low voltage. When a transmitter is placed in 10 mm distance, voltage induced in the transmitter coils and at the same time voltage induced in the receiver side at all three coils with different voltage. At each receiver unit LED is connected three coils to identified the output status. Now one probe is connecting with transmitter coils and other probe is connect with receiver coils. Now both the output voltages are able to see in the form of waveform in the CRO.

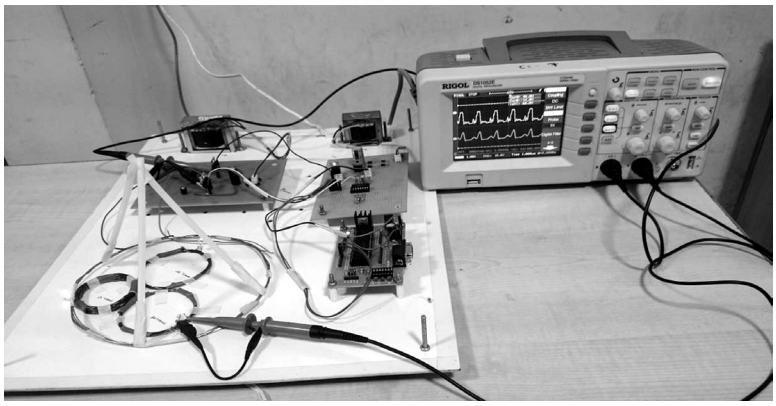

Figure 1: Testing at 10 mm distance

The graph attached at below is showing the result of transmitter input voltages and receiver output voltages. The receiving end voltage efficiency depends upon the distance between the transmitter and receiver coils.

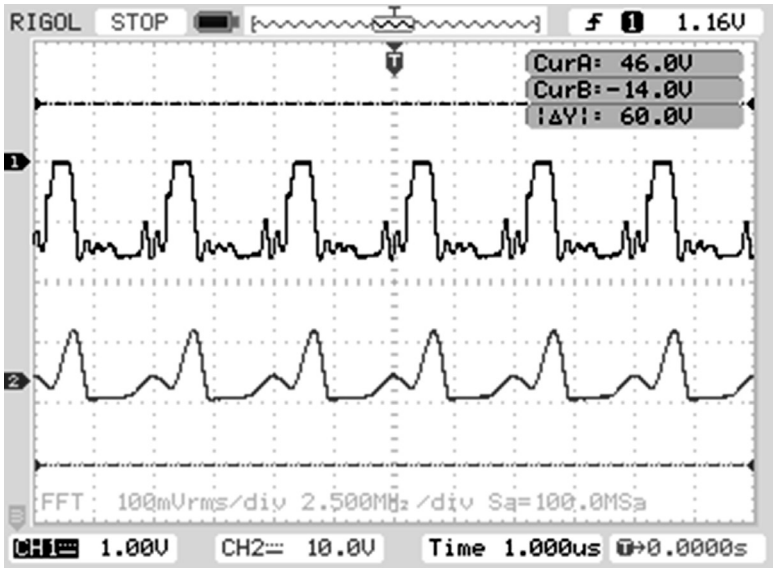

Figure 2: Input vs output waveform

B. Tx&Rx Placed at 70 mm Distance (25 Turns)

During testing of WPTS at distance at 70 mm the Output voltages almost 50% is getting at receiving at receiver side. But there is voltage has been varied with in these three receiver coils. Because three coils are having different number turns. The maximum number of coils(50turns) is getting high voltage and minimum number of coils (25 turns) is getting low voltage. When a transmitter is placed in 70 mm distance, voltage induced in the transmitter coils and at the same time voltage induced in the receiver side at all three coils with different voltage. At each receiver unit LED is connected three coils to identified the output status. Now one probe is connecting with transmitter coils and other probe is connect with receiver coils. Now both the output voltages are able to see in the form of waveform in the CRO. In the testing of WPTS at 70 mm distance for 25 turns coils the LED lights are glowing very low compared to other two LED'S. Because other two coils turn are higher than this coil. This coils output can be used for small voltage application like battery charging, electronic small application unit etc. In CRO the corresponding incoming and receiving output voltage are shown. In CRO can able to get the status of voltages in the form of waveform or chart format.

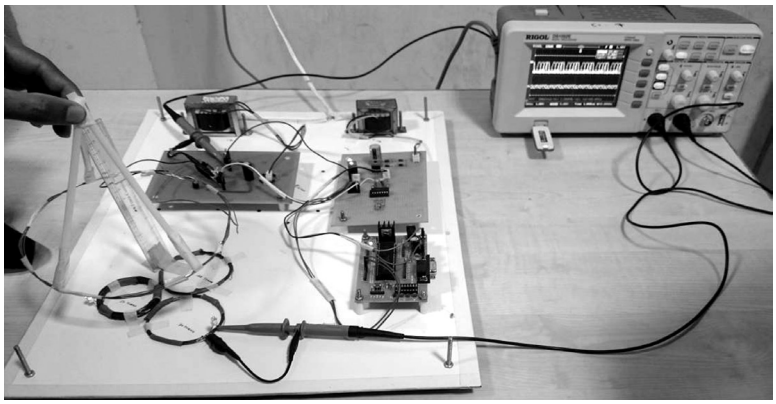

Figure 3: Testing at 70 mm distance for 25 turns coil

In CRO the transmitting coils output is connected in probe 1 and that corresponding Output is shows in the waveform 1 and receiver output is connected in the probe 2 and that's output is shows in the waveform 2.

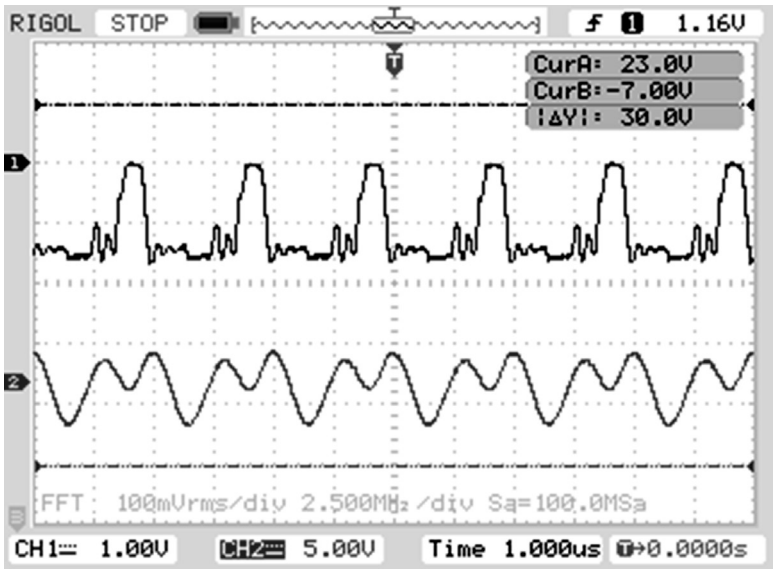

Figure 4: Input vs output waveform

Figure shows the input and output voltages of transmitter and receiver unit for the testing at 70 mm distances. In the Figure its shows the channel 1 and channel 2 voltage are displayed at bottom side of the picture. Channel 1 represents the transmitter voltages and channel 2 is represents the receiver voltages.

During this testing the output voltages is keep on changing due to both are placed in the distances at 70 mm. Because here voltage is induced in the receiver side based on the principle of induction .so there was no interference except distance. The voltage only very depends upon the distance between transmitter and receiver coils. In CRO we can able to get the results like transmitter and receiver voltages in the form of data or waveform. The same coils were having been tested by the distance less than the 70 mm during this condition the incoming voltages will not change and output voltage from the receiver end is getting high compared voltage getting from the distance 70 mm.

C. Tx & Rx Placed at 70 mm Distance (30 Turns)

During testing of WPTS at distance at 70 mm the Output voltages almost 50% is getting at receiving at receiver side. But there is voltage has been varied with in these three receiver coils. Because three coils are having different number turns. The maximum number of coils (50 turns) is getting high voltage and minimum number of coils (30 turns) is getting low voltage. When a transmitter is placed in 70 mm distance, voltage induced in the transmitter coils and at the same time voltage induced in the receiver side at all three coils with different voltage. At each receiver unit LED is connected three coils to identified the output status. Now one probe is connecting with transmitter coils and other probe is connect with receiver coils. Now both the output voltages are able to see in the form of waveform in the CRO. In the testing of WPTS at 70 mm distance for 30 turns coils the LED lights are glowing very low compared to other two LED'S. Because other two coils turn are higher than this coil. This coils output can be used for small voltage application like battery charging, electronic small application unit etc. In CRO the corresponding incoming and receiving output voltage are shown. In CRO can able to get the status of voltages in the form of waveform or chart format.

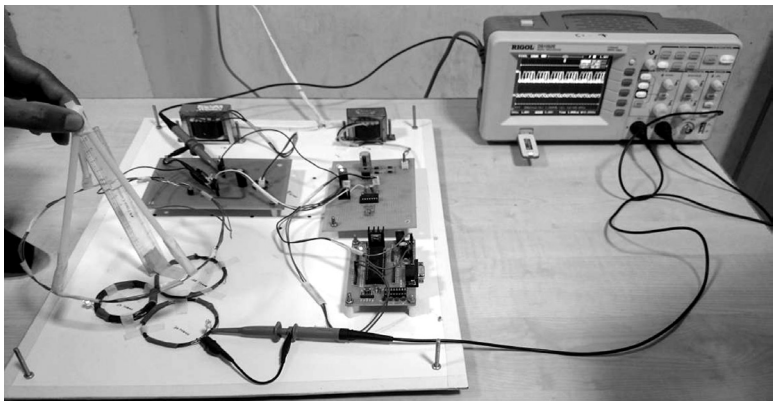

Figure 5: Testing at 70 mm distance for 30 turns coil

In CRO the transmitting coils output is connected in probe 1 and that corresponding Output is shows in the waveform 1 and receiver output is connected in the probe 2 and that's output is shows in the waveform 2.

Figure shows the input and output voltages of transmitter and receiver unit for the testing at 70 mm distances. In the Figure its shows the channel 1 and channel 2 voltage are displayed at bottom side of the picture. Channel 1 represents the transmitter voltages and channel 2 is represents the receiver voltages. During this testing the output voltages is keep on changing due to both are placed in the distances at 70 mm. Because here voltage is induced in the receiver side based on the principle of induction so there was no interference except distance. The voltage only very depends upon the distance between transmitter and receiver coils. In CRO we can able to get the results like transmitter and receiver voltages in the form of data or waveform. The same coils were having been tested by the distance less than the 70 mm. during this condition the incoming voltages will not change and output voltage from the receiver end is getting high compared voltage getting from the distance 70 mm.

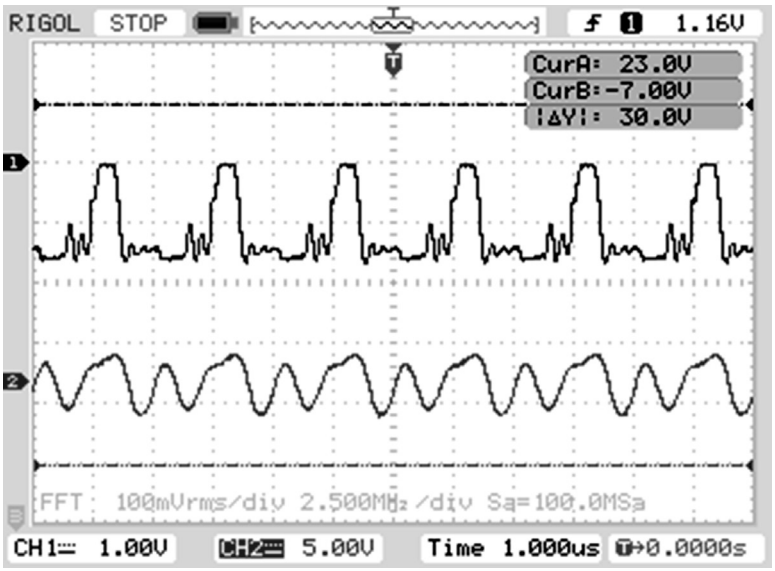

Figure 6: Input vs output waveform

D. Tx & Rx Placed at 70 mm Distance (50 Turns)

During testing of WPTS at distance at 70 mm the Output voltages almost 50% is getting at receiving at receiver side. But there is voltage has been varied with in these three receiver coils. Because three coils are having different number turns. The maximum number of coils(50turns) is getting high voltage and minimum number of coils (30turns) is getting low voltage. When a transmitter is placed in 70 mm distance, voltage induced in the transmitter coils and at the same time voltage induced in the receiver side at all three coils with different voltage. At each receiver unit LED is connected three coils to identified the output status. Now one probe is connecting with transmitter coils and other probe is connect with receiver coils. Now both the output voltages are able to see in the form of waveform in the CRO. In the testing of WPTS at 70 mm distance for 30 turns coils the LED lights are glowing very low compared to other two LED'S. Because other two coils turn are higher than this coil. This coils output can be used for small voltage application like battery charging, electronic small application unit etc. In CRO the corresponding incoming and receiving output voltage are shown. In CRO can able to get the status of voltages in the form of waveform or chart format.

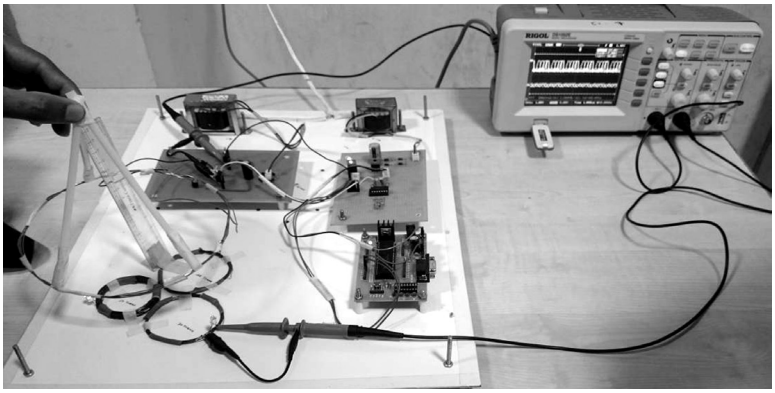

Figure 7: Testing at 70 mm distance for 50 turns coil

In CRO the transmitting coils output is connected in probe 1 and that corresponding Output is shows in the waveform 1 and receiver output is connected in the probe 2 and that's output is shows in the waveform 2.

Figure shows the input and output voltages of transmitter and receiver unit for the testing at 70 mm distances. In the Figure its shows the channel 1 and channel 2 voltage are displayed at bottom side of the picture. Channel 1 represents the transmitter voltages and channel 2 is represents the receiver voltages.

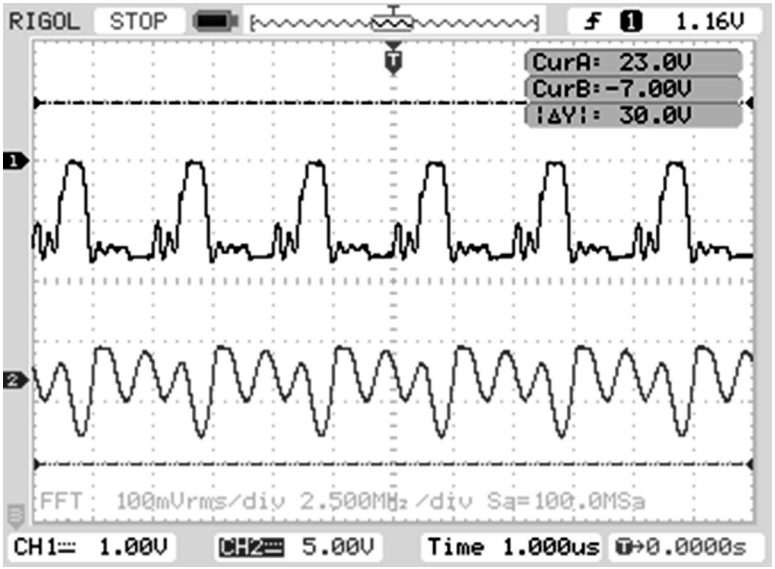

Figure 8: Input vs output waveform

During this testing the output voltages is keep on changing due to both are placed in the distances at 70 mm. Because here voltage is induced in the receiver side based on the principle of induction so there was no interference except distance. The voltage only very depends upon the distance between transmitter and receiver coils. In CRO we can able to get the results like transmitter and receiver voltages in the form of data or waveform. The same coils were having been tested by the distance less than the 70 mm. during this condition the incoming voltages will not change and output voltage from the receiver end is getting high compared voltage getting from the distance 70 mm.

3. CONCLUSION

In this paper the simultaneous wireless power transfer to multiple receiver is analyzed experimentally for different distance and coil turns. It uses the techniques of transmitting power using single transmitter coil with large radius as compared with the receiver coil. Based on the results we can design an efficient multiple load system by changing the number of coil turns and size of the transmitter coil.

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