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Design of Single Transmitter and Multiple Receiver Wireless Power Transfer with Intermediate Coils

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

Abstract: This paper discusses about the experimental analysis of optimal design procedure for single transmitter with multiple load by placing intermediate coils. In a two coil wireless power transfer system, which has low coupling coefficient, the intermediate coil increases the self-inductance and magnetizing inductance of the primary side at around the resonance frequency of the intermediate coil. The coupling coefficient induces bi-furcation phenomenon and increase the system efficiency. A prototype of the WPT system with the intermediate coil is implemented and experimented to verify the validity of the analysis and the proposed design method. The prototype operates at 2 MHz switching frequency and has an air gap between primary and secondary side of 100+mm. An overall system efficiency of 95.57% has been achieved of output power.

1. INTRODUCTION

Wireless power transfer is an emerging topic at global level research. Now days, WPT technology is becoming a need for the future. WPT is a technique for transferring power without using wires. Nikola Tesla proposed the concept of WPT more than a hundred years ago. As more and more portable electronic devices and consumer electronics are developed and used, the need of WPT technology continues to grow. Recently, WPT via strongly coupled magnetic resonance in the near field has been proposed in 2007. The basic principle of WPT is that two self-resonators that have the same resonant frequency can transfer energy efficiently over mid-range distance. A number of researches have been conducted on WPT including equivalent model and analysis of WPT system using circuit theory. A magnetically coupled resonance WPT system uses an intermediate self-resonator coil to extend the coverage of wireless power transfer that is coaxially arranged with both transmitter and receiver self-resonant coils. It was also reported that magnetically coupled resonance WPT has several valuable advantages, such as efficient midrange power transfer, non-radiative, and nearly Omni-directional. It is certain that these properties will help to improve the performance of current WPT systems and will be utilized well for various wireless power transfer applications such as electric vehicles, consumer electronics, smart mobile devices, biomedical implants, robots, and so on

2. SYSTEM ANALYSIS

The 2D coil setup as shown in Figure 1 consist of two transmitting coil placed perpendicular to Ech other and one receiving coil. The index of 1, 2, 3 denotes the transmitting coil 1, 2 and receiving coil respectively. The self-inductance, capacitance and resistance are named Li, Ci and Ri, where $i = 1, 2, 3$. Equivalent circuit model of the 2D coil system is shown in Figure 2. By applying kirchoff's voltage law to the equivalent circuit the voltage current relationship can be described as

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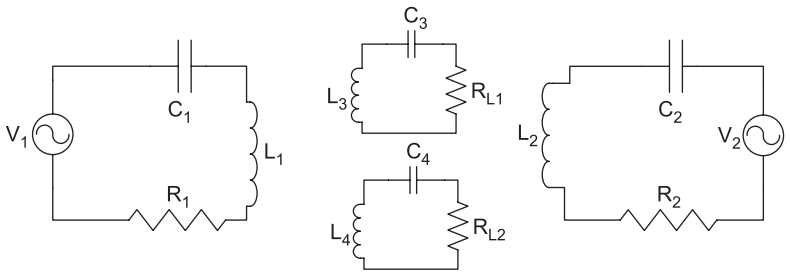
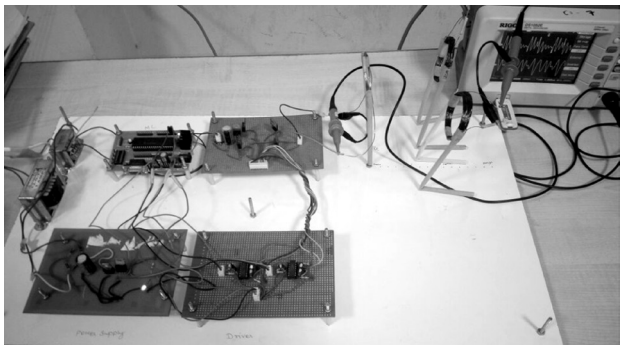


Figure 1: Equivalent Circuit of two coil WPT with Intermediate coil

3. EXPERIMENTAL ANALYSIS

Based on the applications dimensions, power requirement, distance variation the size of the coil is designed. In case of high power applications, the efficiency will be the prime consideration in the design, so choosing a high Q coil would be better with compact size. In this work we use a standard AWG-14 wire for the transmitter coil and AWG-22 wire for the receiver coil**.**



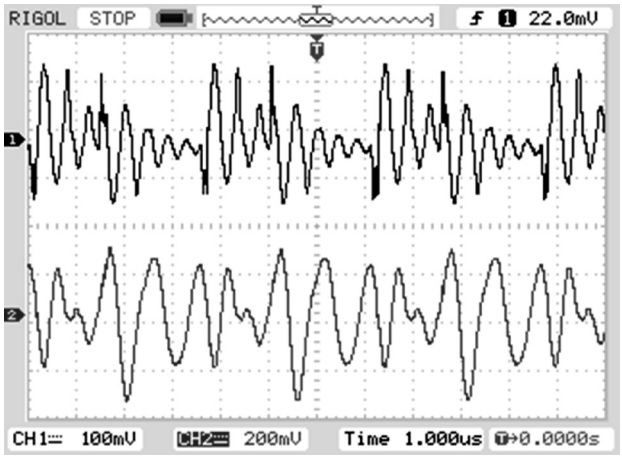
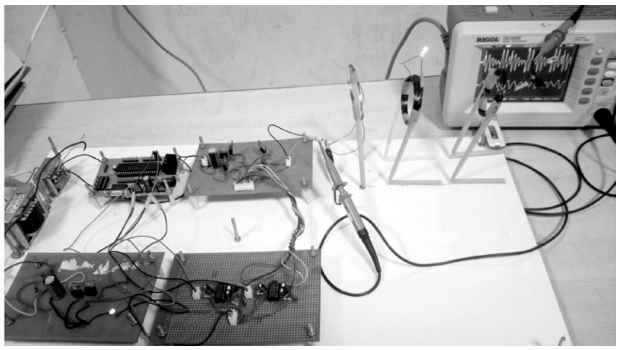


Figure 2: Tx and Two Rx Coils Placed in Parallel



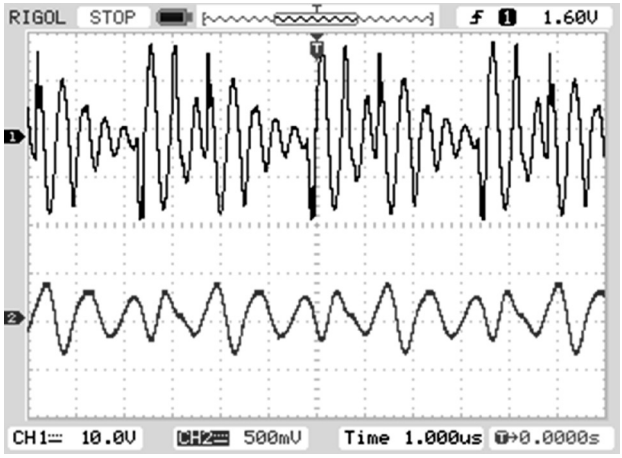


Figure 3: Tx and Two Rx Coils Placed in cascade

4. CONCLUSION

The experimental analysis of single transmitter and multiple receiver system This paper discusses about the experimental analysis of optimal design procedure for single transmitter with multiple load by placing intermediate coils. In a two coil wireless power transfer system, which has low coupling coefficient, the

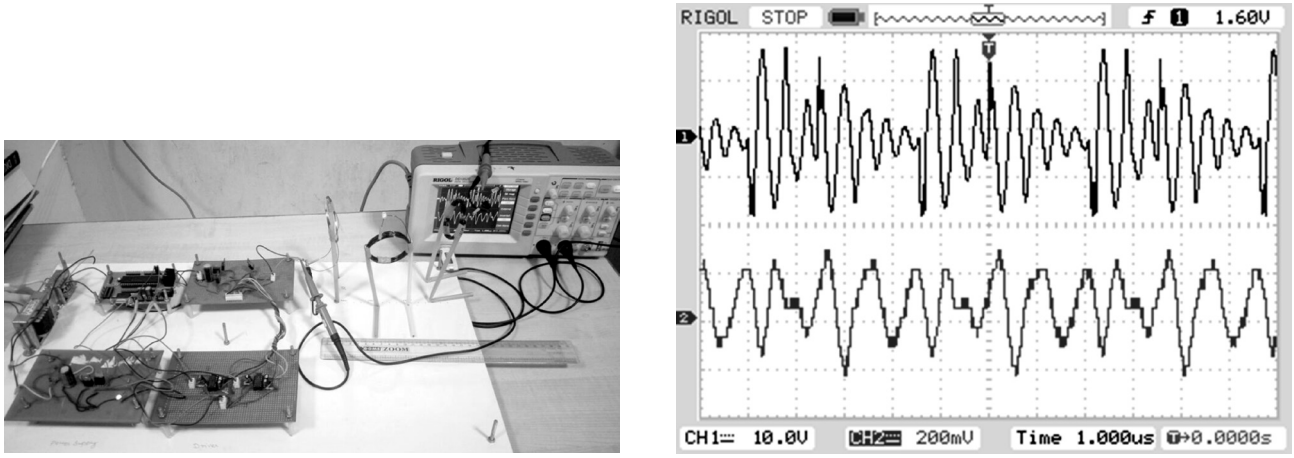


Figure 4: Tx with Intermediate coils

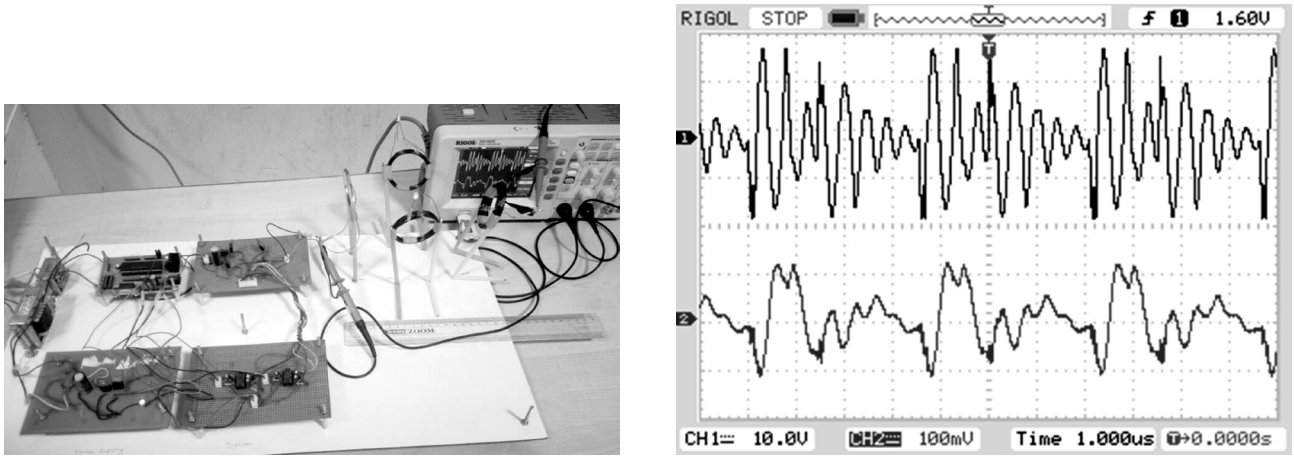


Figure 5: Tx and Four Rx coils placed in Align

intermediate coil increases the self-inductance and magnetizing inductance of the primary side at around the resonance frequency of the intermediate coil. The coupling coefficient induces bi-furcation phenomenon and increase the system efficiency. A prototype of the WPT system with the intermediate coil is implemented and experimented to verify the validity of the analysis and the proposed design method. The prototype operates at 2 MHz switching frequency and has an air gap between primary and secondary side of 100+mm. An overall system efficiency of 95.57% has been achieved of output power.

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