High Efficiency Wireless Power Transfer System Robust against Misalignment

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***Abstract*—The power transfer efficiency of magnetic resonance coupling wireless power transfer (WPT) system is sensitive to the alignment of the transmitter and receiver. In this paper, a multi-coil WPT structure is proposed to enhance power transfer efficiency. It is shown by experimental results that the proposed WPT system can achieve 90.2% efficiency in aligned working conditions. Meanwhile, this WPT system maintains over 70% efficiency from 0 to 55 mm misalignment distance, which is 66% of the length of the Rx board. The proposed WPT system is suitable for the applications of implant devices for biomedical health care and treatment.**

I. INTRODUCTION

Wireless power transfer (WPT) technology has enabled a wide variety of portable consumer electric, medical, and industrial devices. WPT devices are desired to have high power transfer efficiency and robust against misalignment tolerance between the transmitter (Tx) and receiver (Rx). Lots of techniques have been reported in the literature. However, how to maintain high efficiency in case of misalignment between Tx and Rx coils is still the limitation for many WPT systems. That is, a WPT system usually achieves its maximum efficiency under one condition only. Once the Tx or Rx is changed from that optimum position, the efficiency decreases drastically due to the mismatch.

II. METHODOLOGY

In order to achieve high efficiency under misalignment conditions, a double layer magnetic resonance coupling WPT system with two pairs of resonators is proposed in this paper. Fig. 1 demonstrates an overview of the proposed design. Each side of the WPT system has two individual resonators at the same resonant frequency. Under aligned conditions, Resonator 1 is coupled with Resonator 1* and Resonator 2 is coupled with Resonator 2*.

For a single resonator, a copper PCB track forms each of the two parts of a coil with the same spiral directions. An external capacitor is added between two terminals of the PCB tracks to constitute a resonator. The two layers are connected together to achieve a large inductance. The feed loop is designed to make sure that the magnetic field generated by the feed loop will be constructively coupled to the TX coil. The receiver part is designed in a similar way.

III. RESULTS AND DISCUSSION

The proposed WPT system was fabricated. The performance of the fabricated WPT system was measured when both aligned and misaligned. Fig. 2 shows the efficiency as a function of the misalignment distance normalized to the length of the Rx board. The efficiency declined slowly from 0 to 45 mm displacement of the Tx, where resonator 1* was coupled with resonator 1 and resonator 2 simultaneously. From 45 mm to 55 mm misalignment distance, which was 66% of the length of the Rx board, there was strong coupling existing between resonator 1* and resonator 2 so that the efficiency was still over 70%. The performence of the proposed WPT system is also compared with other WPT systems desinged against misalignment [1][2] and the conventional method using one resonator with a single spiral coil, as shown in Fig. 2. It is shown that the proposed WPT system can achieve much higher efficiency than previous designs.

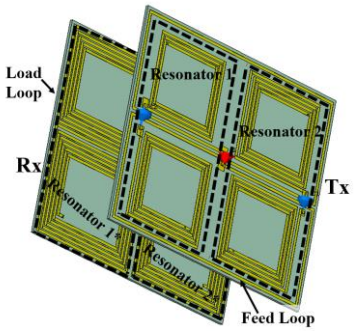

Fig. 1 The proposed multi-coil WPT system

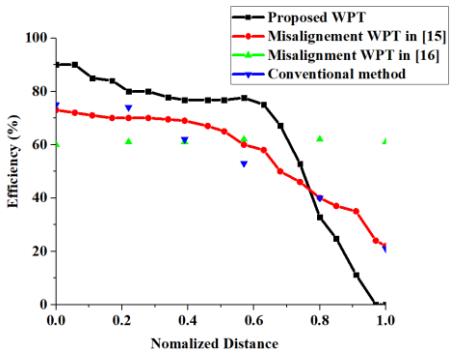

Fig. 2 Comparison of the efficiency when misaligned of the proposed WPT system with Ref [1], [2] and the conventional method

REFERENCES

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