Comparison of Power Efficiencies between Parallel and Series Configuration for Receiver Circuit in a Wireless Power Transmission system Using an LC Power Oscillator

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Abstract

In recent years, wearable devices have become increasingly important in improving quality of life. Wireless power delivery to such devices is a promising technology for the miniaturization. Magnetic resonant wireless power transmission is a suitable method for such applications. The operating frequency should be varied corresponding to change the coupling coefficient. Recently, use of power oscillators in the transmission circuit is investigated for such cases. An LC power oscillator is one of the candidates for such applications because of the high efficiency and the simple circuit configuration. In this paper, an improved LC power oscillator suitable to wireless power transmission was proposed and the power efficiencies between the parallel and series configuration for the receiver circuit were compared.

1 Introduction

In recent years, wearable devices have become increasingly important in improving quality of life. Power delivery to such devices is important [1]. Wireless power transmission is one of the power delivery methods for miniaturization of the devices. The magnetic resonant wireless power transmission is widely used as such power supply method. The coupling coefficient between the transmission and receiver coil can vary with movement of the user. The operating frequency should be adjusted because the resonant frequency can be changed with the coupling coefficient. Recently, wireless power transmission methods with power oscillators are investigated [2]. The oscillation frequency is automatically adjusted with change of the resonant one. An LC oscillator among such power oscillators is one of the candidates due to the high efficiency and the simple circuit configuration [3]. In this paper, an improved LC oscillator without the center tap of the coupling inductance was proposed. The power efficiencies between the parallel and series configuration for the receiver circuit in the transmission system were compared.

2 An Improved LC oscillator Suitable to Wireless Power Transmission

A typical circuit of a typical LC type oscillator is shown in Fig. 1. The inductance with a center tap was divided to two part due to its center tap. Each divided inductance is coupled to the receiver coil. The coupling coefficients can be varied with the movement of the receiver coil in the case of wearable applications. The analysis and design can be difficult because two coupling coefficients must be controlled. An improved circuit is shown in Fig. 2. In the new circuit, another bias line with a choke coil is added instead of using the center tap of the coupling inductance. The analysis is easier because the coupling part is reduced to one.

3 Comparison of power efficiency between parallel and series receiver circuit

In a wireless power transmission system with the circuit shown in Fig. 2 as a transmitter, a parallel or a series circuit can be used in the receiver side. The power efficiencies between them were compared using a circuit simulator (LT spice). The circuit parameters are shown

in Table. 1. The AC to AC power efficiencies and the DC to AC efficiencies by the equation are shown in Fig. 3 and Fig. 4 as a function of the coupling coefficients. The efficiencies were increased as the coupling coefficients. The efficiencies for the parallel configuration were larger than for the series one in a range of coupling coefficients used in the simulation.

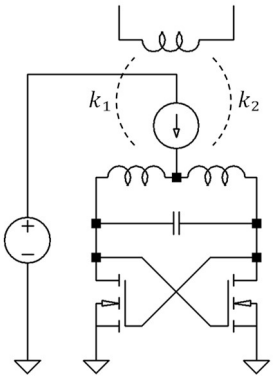

Fig. 1: Typical LC osccillator.

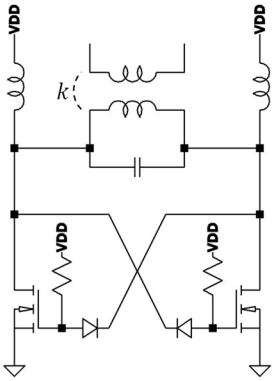

Fig. 2: A improved LC oscillator without center tap of the coupling coil.

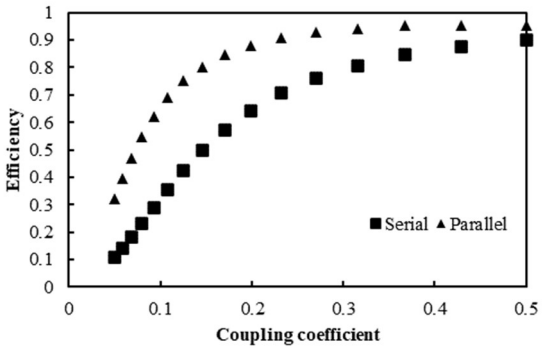

Fig. 3: AC-AC Efficiencies

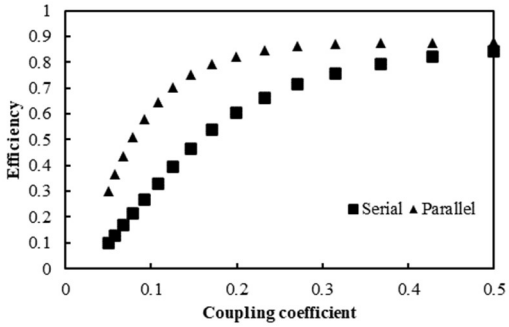

Fig. 4: DC-AC efficiencies

4 Conclusion

A magnetic resonance wireless power transmission with an improved LC power oscillator was investigated using a circuit simulation. The circuit will be suitable to applications to supply power to wearable devices. The power efficiencies were compared for a series and parallel receiver circuits. The efficiencies for the parallel configuration were larger than for the series one.

References

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