Wireless Power Transfer
based on Strongly Coupled Magnetic Resonance
(CKJ1b-13)

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Project Overview

Today, bringing an adapter/connector or powerbank in case of running out of energy has already become an indispensable part in human’s daily life. However, this inevitably often causes a lot of inconvenience to users. Because of this phenomenon, wireless power transfer (WPT) technology has attracted the attention of scientists and engineers all around the world. While there are several proposed approaches like using electromagnetic (EM) field and magnetic induction similar to a transformer, WPT via strongly coupled magnetic resonances in the near field dominates the research owing to its high power efficiency and low-radiation nature.

In our project, we are going to build a WPT system which comprises of one transmitter and one receiver. The transmitter describes the flow of regulating a high input voltage to a certain DC value, then converting the DC signal to Radio Frequency signal and triggering the source resonator to generate an oscillating magnetic field. On the receiver side, the device resonator captures the field nearby and drives the load at the end of the receiver circuit.

Aim

We aim at developing a WPT circuit that can light up a Light Emitting Diode (LED) at a distance above 10 cm away from the transmission coil with high transmission rate through achieving Magnetic Resonance Coupling (MRC).

Objective

By producing an efficient WPT circuit via magnetic resonance coupling, adapter/connector or powerbank is no longer needed so that charging/operating electrical and electronic products gadgets become more convenient than the traditional way of application.

Project Overview

Design Phase:
To find and analyze different circuits from others. Then among these, we will pick the best scheme and improve it.

Implementation Phase:
There were three stages in the project. They are illustrated as follows:

- Circuit Comparison
- Hardware Implementation and Testing
- Improvement

Testing Phase:
In circuit comparison stage, the frequency spectrum of the magnetic fields generated by the coils from different circuits was measured by a spectrum analyzer.

In hardware implementation, the longest distance between coils of the chosen circuit was tested by adjusting the capacitances of the variable capacitors in transmitter and receiver side respectively.

In the stage of improvement, a splitting of peak at the desired resonance frequency in the magnitude plot of S21 in VNA was tested. Also, operating frequency and peak-to-peak voltage of the resonating coils was also tested by probing the terminals of oscilloscope to the ends of the coils.

Evaluation Phase:
Finally, result of frequency spectrum displayed in spectrum analyzer was evaluated.

Secondly, two coils were brought together and the results of S-parameters (S11/S22 and S21/S12) shown in VNA was evaluated.

Lastly, the result of peak to peak voltages of coils measured by oscilloscope was evaluated.

Result

When the gap between the coils is about 6-7 cm, a small peak can be observed in traces S11 and S22 at 14MHz.

When the gap is reduced to 3 cm, the peak became sharper and the trace S21 shows a peak in the opposite direction at 14 MHz.

When the transmitter and receiver coil are close enough to each other, magnetic resonance coupling occurs. Single peaks in S11, S22 and S21 at 14MHz has split into two peaks.

Discussion and Conclusion

This project has successfully established magnetic resonance coupling between coils at 14MHz. The transmission coefficient, S21, has increased dramatically so that maximum power transfer is obtained resulting in high power efficiency.