An Improved Magnetic Coupling Resonant Wireless Charging System for Cell Phones

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4.AC/DC Converter:4.2Resonant and Quasi-Resonant Topology Power Supplies;Oral or Poster Presentation

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Abstract： As a new theory put forward in recent years, magnetically coupled resonant wireless power transfer technology (WPT) has a promising prospect. However, there are still many problems to be solved in practical application, such as low transmission efficiency and large power loss. In this paper, to improved the transmission efficiency of magnetic coupling resonant wireless charging system for cell phones, we use the Litz wire coil and compare the difference between the circuit transmission efficiency of common switch tube and GaN switch tube. The transmitter changes 20V DC output by the adapter into AC, through the half-bridge high-frequency inverter circuit. It uses capacitors and coils in series resonance to transmit the power from transmitter to receiver. Through the filter circuit and LM7805 regulator, the output 5V constant voltage is got, so as to achieve the effect of ordinary charger. The proposed scheme is validated by the simulation results and tested results with a prototype.

Keywords: Magnetic Coupling Resonance; Cell Phone Wireless Charging; Half-bridge Inverter

I. Introduction

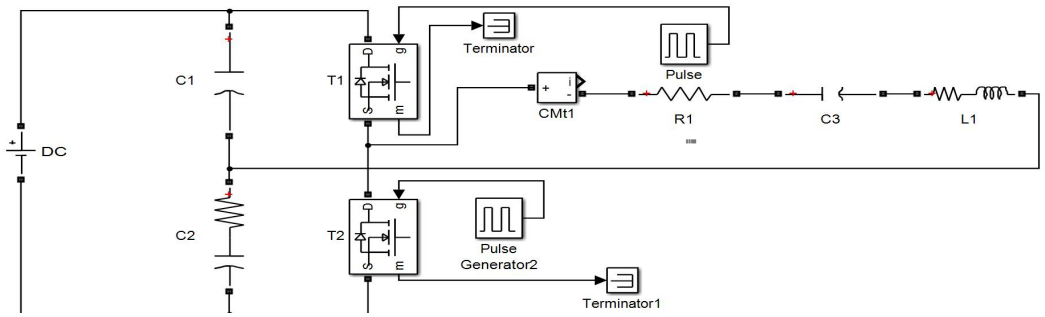
Because of advantages of avoiding the direct contact between electrical equipment and electrical wire in the grid and achieving electrical isolation, wireless power transfer technology (WPT) is gradually developed. Besides, its transmission process is safe and reliable so that it can get rid of the wire wearing and aging problem. In November 2016, magnetically coupled resonant technology was proposed by Marin Soljacic [1] with broad prospects in the field of portable mobile devices, electric vehicles and aerospace.

Nowadays, the technologies used in the field of WPT include electromagnetic induction, magnetic coupling resonance, microwave, electric field, laser, ultrasonic and alike [2], among which, electromagnetic induction, magnetically coupled resonance and microwave are three mainstream different technologies.

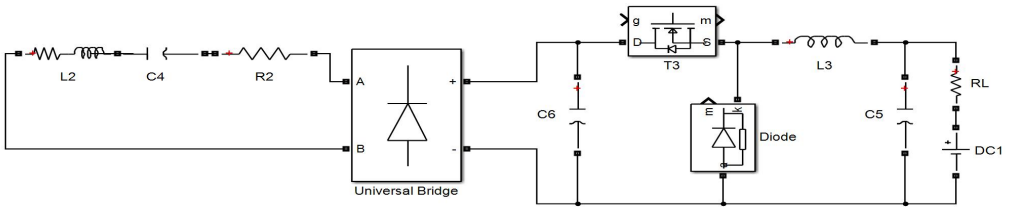
At present, commonly used magnetic coupling resonant circuit topology are ss topology, sp topology, ps topology and pp topology [3−4] in which ss topology with the highest transmission efficiency, is suitable for high-frequency and low-power programs. As the target output power of the program within 10W, in order to achieve high transmission efficiency, we choose ss topology. We select magnetic coupling resonant technology to design a prototype, achieving the function of ordinary mobile phone charger.

Ⅱ.Topology of WPT

Magnetic coupling resonant wireless charging system is depicted in Fig.1.



(a) Input circuit topology



(b) Output circuit topology

Fig.1 Magnetic coupling resonant wireless charging system

III. Schematic and working principle

As shown in Fig.2, the transmitter uses half-bridge inverter circuit, emitting 450KHZ PWM wave to change the output voltage of 20V DC produced by transformer into alternating current by TLC6900 chip, and transmit electrical energy through series resonance between Litz coil L1 and resonant capacitor C1-C4. In order to reduce loss and improve transmission efficiency, the coil adopts the Litz wire and is in the shape of spiral plane [5]. In the actual experiment, the working frequency is about 450KHZ, LTC6900PWM generator is adopted, the ordinary MOSFET driver chip is TPS28225 and the GaN MOSFET driver chip is LM5113.

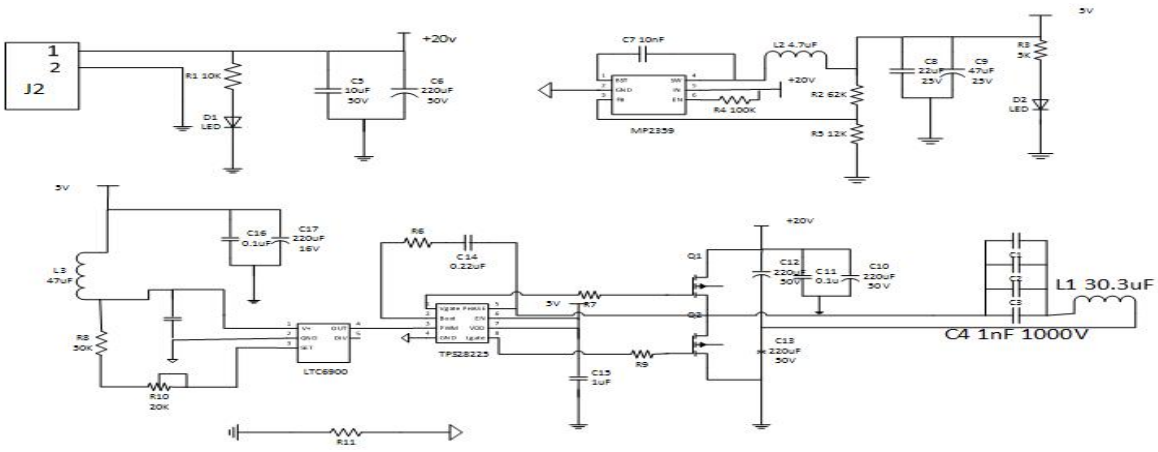


Fig.2 Input circuit diagram

The receiver filters the electric energy transmitted by the resonance through the filter circuit. In order to achieve the function of cell phone charger, we cascade voltage stabilizing circuit with LM7805 chip to ensure that the final output voltage is 5V constant voltage and the current is not greater than 1.5A.

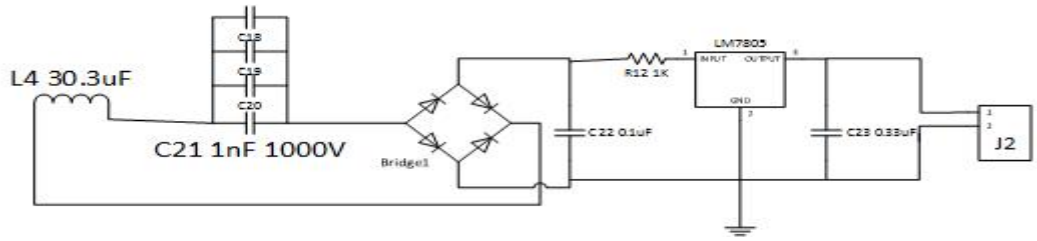
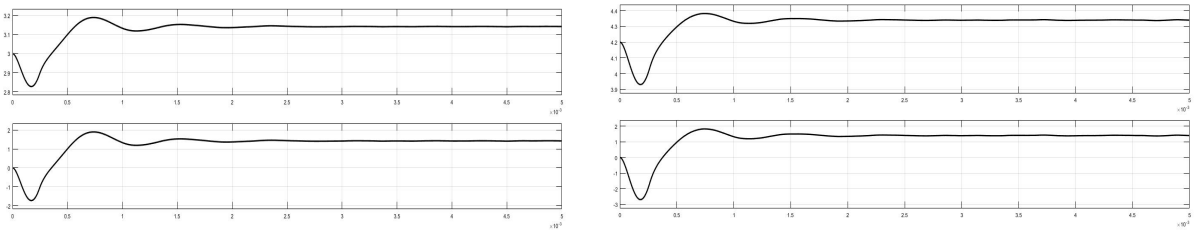


Fig.3 Output circuit diagram

IV. Simulation Analysis

Taking transmission distance of 10 cm as example, two simulations of Fig.4 are given here.(phone lithium battery voltage range is 3v~4.2v)



Case.1. DC1=3V Case.4.DC1=4.2V

Annotation：The abscissa is the time and the ordinate are the voltage value and the current value respectively.

Fig.4 Output oscilloscope waveforms

In the lithium battery charging process, the voltage rises from 3V to 4.2V. The circuit output voltage peak is 4.2V, and the output current peak is 2A. When the electricity of phone battery is low, the voltage of the lithium battery is low and the charging current is high. As the voltage of the lithium battery is charged and the voltage is increased, the output current decreases slowly to achieve a good charging effect. As the actual circuit using LM7805 regulator, the output current will not be greater than 1.5A so that it can effectively prevent overcharge and simulation results are able to meet the test requirements.

V. Conclusions

This paper presents a magnetic coupling resonant wireless charging scheme, the output of 5V constant voltage power supply, and a brief introduction to the theoretical analysis method as well as gives the simulation topology and hardware schematic diagram and analyzes the working principle. To verify the feasibility of the scheme, the simulation results are given.

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