RECTIFIER LOAD ANALYSIS FOR ELECTRIC VEHICLE WIRELESS CHARGING SYSTEM

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ABSTRACT:

This paper presents the analysis of rectifier load used for electric vehicle (EV) wireless charging system, as well as its applications on compensation network design and system load estimation. Firstly, a rectifier load model is established to get its equivalent input impedance, which contains both resistance and inductance components, and can be independently calculated through the parameters of the rectifier circuit. Then, a compensation network design method is proposed, based on the rectifier load analysis. Furthermore, a secondary side load estimation method and a primary side load estimation method are put forward, which adopt only measured voltages and consider the influence of the rectifier load. Finally, an EV wireless charging prototype is developed, and experimental results have proved that the rectifier equivalent load can be correctly calculated on conditions of different system load resistances, rectifier input inductances, DC voltages, and mutual-inductances. The experiments also show that rectifier load equivalent inductance will impact system performances, and the proposed methods have good accuracy and robustness in the cases of system parameter variations.

Keywords: Battery charge control, bidirectional buck– boost converter, full-bridge bidirectional converter.

1. INTRODUCTION:

In recent years, the keen attention being paid to transportation electrification and the rising deployment of electric vehicles (EVs) have made it essential for researchers, enterprises, and governments to deal with several barriers to the wide acceptance of EVs, including inconvenience of charging, unsatisfactory driving distance, and relatively high cost. Wireless power transfer (WPT) technology is an effective approach to address the first problem of inconvenient charging, due to the fact that it removes the need for cables or plugs, galvanic isolation of on-board electronics and additional safety concerns with operating in rain and snow. Thus, it offers consumers a seamless and convenient alternative for charging efficiently. Till now, there has been considerable literature focusing on the application of WPT technology in real wireless charging systems for electric vehicles on the road. Magnetic

1.1. History:

At the primary side, which is usually installed under the ground, a high-frequency current is generated in the resonant tank, resulting in high-frequency electromagnetic. The primary coil, together with an inductor capacitor-inductance (LCL) parallel resonant circuit, generates a high-frequency electromagnetic field, which is mainly installed beneath the ground. The pickup coil is magnetically coupled to the primary coil through the electromagnetic field, and the inductive current in the pickup coil is regulated with the rectifying and filtering circuits, which are applied to charge the onboard battery pack. In general, a control circuit is included in both primary and pickup sides to adjust the charging power according to the requirements of the battery. However, the transfer power and efficiency of the system are reduced due to factors caused by different heights of the EV chassis and parking in an inaccurate position, which have serious impacts on output power and efficiency of wireless charging systems. Besides, the WPT system has only worked in unidirectional mode such that the energy stored in the battery of the EV cannot feed back to the grid. This limitation seriously hinders the application of the WPT system in the field of EV charging.

WPT technology is a contactless power transfer method using magnetic field coupling, and therefore the distance of transfer should be as long as possible to make WPT technology widely used in industrial and household applications. To realize quick charging in some applications, e.g., electric vehicles (EVs), WPT systems used in these applications should have the feature of high-power transfer. Due to the application of high-frequency converters and the existence of ESRs of coils in WPT systems, it is necessary to study the improvement of efficiency of WPT systems. Coil misalignment is a common problem in WPT systems, as it can lead to the fluctuation of transferred power. Therefore, a WPT system with tolerance of misalignment is investigated in terms of circuit topology, magnetic structure, and control methods.

First, this paper introduces the basic structure and principle of the WPT system, and we present a novel relay bidirectional WPT system and the system topological structure. In addition, the working mode is introduced in detail. Second, the bidirectional power transfer mode and power control are researched. The shift phase control is applied to the primary and pickup, realizing the regulation of the power transmitter of the primary and received power of the load. Furthermore, the amount of the power flow and the direction can be controlled by regulating the shift phase angle. Third, to optimize the system parameters, this paper focuses on the transfer power and efficiency. Finally, the working process of the system is verified by simulation and experiment.

2. PREVIOUS STUDY:

Based on the previous researches, an effective method to quantitatively analyze the equivalent load of WCS rectifier is put forward in the paper firstly. The equivalent load can be independently calculated through the parameters of the rectifier circuit, and the results are basically not affected by other WCS parts. Secondly, a compensation network design method is proposed considering the equivalent impedance of the rectifier load, especially the equivalent inductance. This method will further decouple the primary and secondary side design, to achieve four system performance indicators at the same time. Thirdly, the effects of the rectifier non-linear process are taken into count to estimate the system load resistance. The proposed primary side load estimation method only adopts high frequency voltages, does not need to measure the currents, and can avoid the phase delay deviations. Also, it does not require wireless communication between the primary and secondary sides.

3. PROPOSED SYSTEM:

Representation of WIRELESS POWER TRANSMISSION USING THE TECHNIQUE OF MUTUAL INDUCTANCE MODEL is being designed in this paper to show that equipments can be run without any usage of wires and just by transmitting power to them wirelessly. This model is also focusing on the needs to saving on electricity for future use and also more efficient, where many types of equipment can be run through single transmitter without any involvement of tedious work of wires which are not completely efficient as they also cause loss of power during transmission. Also this paper can be used as a reference for further development as per coming technological advancements in the subject of wireless power transmission.

The conventional use of is although made possible through the usage of wires only. Although in present day electricity generation system is not much efficient in terms of energy transfer. Almost about 20 to 30% of energy is lost during the time of distributing the electricity. Also, other than that in past times, product designers and engineers have faced many challenges that involve power: the continuity in power supply, recharging of batteries. Although those challenges are still remaining , new demands arising from increased usage of mobile devices and operation in wet environments that means in like rainy seasons ,which means that designers hence require new approaches in supplying power. Also in today's world it is must to save on to electricity which in conventional use is being spent much more than required. Hence as necessity is mother of invention wireless power transfers (WPT). WPT is the transfer of electric energy from a power source to an electric load without a direct physical connection between them, usually via an electromagnetic field. The basic function of WPT is allowing electrical devices to be continuously getting charged and losing constraint of a power cord. Hence using this efficient way of transmission of electric power from one point to another in vacuum or an atmosphere with no use of wire or any other substance. It also has applications where either an instantaneous amount or a continuous energy supply is needed, also stating the fact that conventional wires are at times unaffordable, also inconvenient as well as expensive and hazardous or impossible. The power can be transmitted using microwaves, through magnetic induction method also lasers. WPT is a technology which can transport power to even remote locations, sometimes are impractical to reach.

4. SIMULATION RESULTS:

An LCL converter can be formed by adding an LC compensation network on the primary side or on both primary (transmitter) and secondary (receiver) sides. The advantage for the LCL converter at the resonant frequency is that the current in the primary-side coil can be independent of the load condition, or in other words, the LCL network performs like a current source. However, the design of an LCL converter usually requires additional inductors. To reduce the additional inductor size and cost, usually a capacitor is put in series with the primary-side coil, which forms an LCC compensation network. By utilizing an LCC compensation network, a zero current switching condition could be achieved for higher efficiency by tuning the compensation network parameters. Also, when the LCC compensation network is adopted at the secondary side, the reactive power at the secondary side could be somehow compensated and the current distortion might be reduced. Consequently, in order to verify the proposed theoretical derivation, an integrated LCC compensation topology is selected as a specific research object. Extension of the presented analysis to other topologies is based on simple transformation rules.

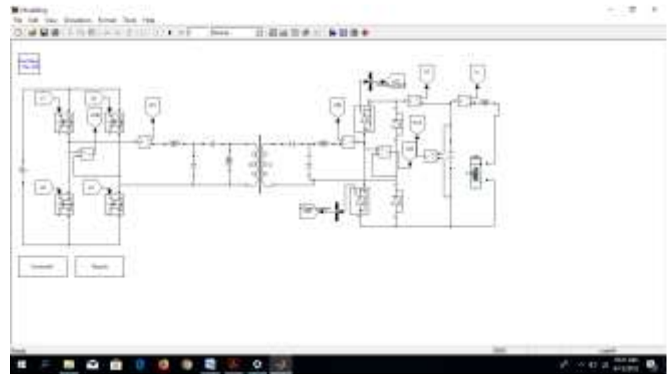

Fig 4.1.Simulation model.

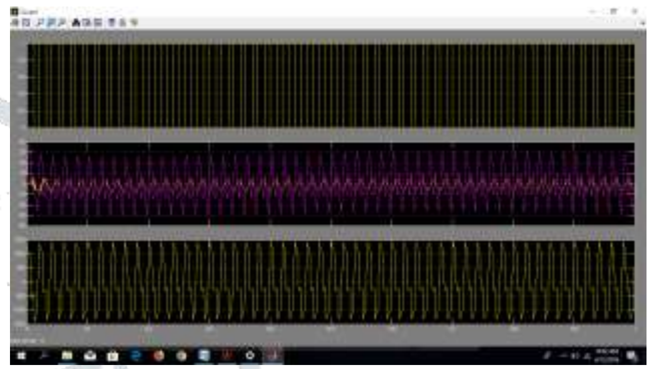

Fig.4.2. Simulation results at voltage and current.

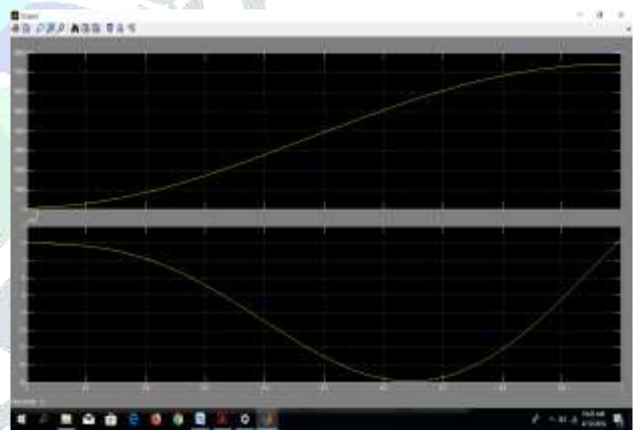

Fig.4.3.Output voltage and current

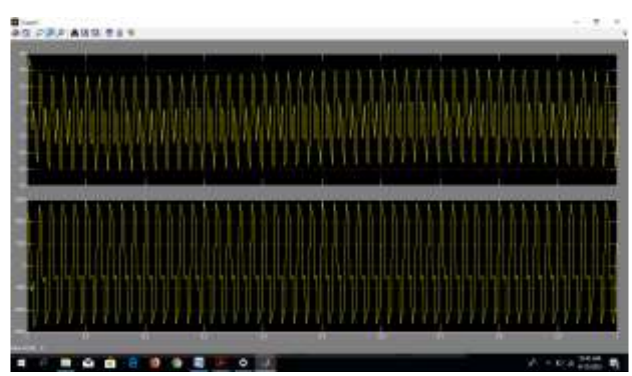

Fig.4.4. Receiving end side current

Fig.4.5.Voltage and current at primary winding side.

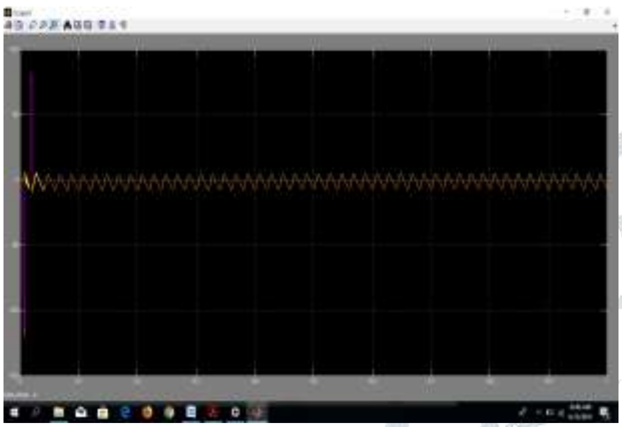

Fig.4.6.Voltage and current values at secondary winding side.

5. CONCLUSION:

The exploration of the ac power factor characteristics and voltage phase relationships in wireless chargers of EVs is proposed, in order to correct a common misunderstanding that the ac output power factor of a WPT system is always unity. The CCM and DCM with various frequencies are discussed, covering expected operation conditions. An equivalent output voltage curve is introduced to decrease the calculation complexity in DCM. With simple transformation, the presented methodology for an integrated *LCC* compensation topology can be readily extended to other WPT systems. It also contributes the new topology design and realization of some control strategies with precise power calculation/estimation required. The comparison of experimental and calculated results proves the correctness and validity of the proposed strategy.

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