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# Double-Sided LCC Compensation Network and Its Tuning Method for Wireless Power Transfer for EV charging

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***Abstract: This research explores a double-sided LCC compensation network's utilization in an inductively coupled wireless power transfer (WPT) system for electric car charging applications and its wireless power transfer tuning procedure (WPT). A wireless power transmission system is offered with a double-sided LCC compensating network. The compensation circuit is crucial because it may be used to adjust the system's resonance frequency, lower reactive power in the power electronics converter, and boost the efficiency and capability of transferred power.***
***The proposed architecture and its tuning technique allow the system to operate at a constant switching frequency since the resonant frequency is unaffected by the coupling coefficient between the two coils and is also independent of the load status. Also, it has been discovered that the corrected receiving coil inductance is a useful tuning parameter for ensuring the primary side zero voltage switching (ZVS) operation.***
***Keywords: Electric Vehicle, Wireless Power Transfer (WPT), Zero Voltage Switching(ZVS), Battery Charger, Compensation topology.***

## I. INTRODUCTION

Nikola Tesla proposed the idea of wireless power transfer (WPT) using magnetic resonance more than a century ago. It has only recently been clear that a WPT system can be implemented affordably enough to have a commercial value thanks to advancements in power electronics technology.

Wireless power transfer, also known as wireless charging or inductive power transfer, has been successfully used in low-power applications for biomedical implants, smartphones and other electronic devices, chemical plants, lighting, and underwater vehicle applications. Since it eliminates the energy storage and range restrictions associated with electric vehicles (EVs), this technology holds considerable promise for the industry. In addition to the rapidly expanding interest in electric vehicles (EVs) and plug-in hybrid electric vehicles (PHEVs), wireless charging has recently caught the attention of researchers, automakers, and consumers as a new method of charging batteries.

WPT is more practical, weatherproof, and electric shock-resistant than conductive power transfer, which is often plug-in. Inductive power transfer (IPT), one of two non-radiation-based power transfer technologies, is appropriate for greater power applications, whereas capacitive power transfer (CPT) is appropriate for lower power applications. Since the charging power level for electric vehicles (EVs) is measured in kW, IPT is preferred for EV charging applications. Many businesses, like WiTricity, Evatran, Qualcomm, and others, have already created a few products that can transfer power through a certain air gap with an acceptable power level and efficiency.

## II. METHODOLOGY

### *A. WPT Technologies*

In the 1890s, Nikola Tesla conducted numerous tests on WPT at Colorado Springs, USA, and is credited with introducing the technology. The air medium employed by WPT, which is powered by charged particles, is used to transport energy between the transmitter and receiver. Depending on the uses, power ratings, and transmission distance, the energy can be transported using electromagnetic waves, an electric field, or a magnetic field. The WPT techniques are classified into the near field and far field depending on the distance, as shown in Fig.

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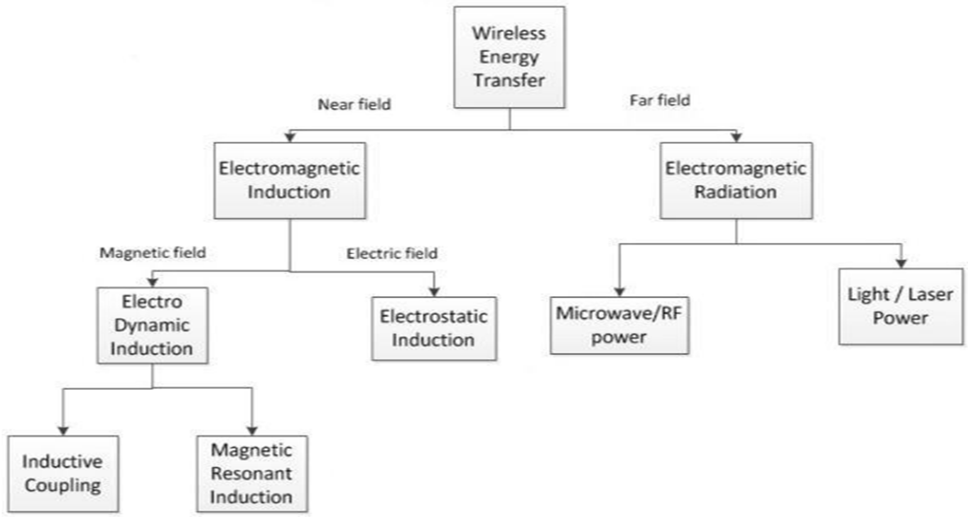


Fig 1: Types of WPT Technologies

Near-field techniques are used to transmit energy over small distances, while far-field techniques are used to transmit energy over large distances. Currently, the majority of mobile gadgets, electric vehicles, and home appliances employ WPT because of its benefits. Defense systems and satellites powered by solar energy also employ it.

## III. DOUBLE-SIDED LCC COMPENSATION NETWORK

### *A. Double-Sided LCC over other topologies*

By including an LC compensation network between the converter and the transmitting coil, an LCL converter is created. When the system operates at the resonant frequency, the LCL converter has two benefits. First of all, the inverter only provides the load with the active power it needs. Secondly, the primary-side coil's current is unaffected by the load situation. For bidirectional power transfer, an Lc Compensation network at both primary and secondary sides is suggested. The two inductors in an LCL converter must typically have the same value. Typically, a capacitor is connected in series with the principal side coil to create an LCC compensation network, which reduces the size and cost of the supplementary inductor. A zero current switching (ZCS) state could be produced by using an LCC compensation network and fine-tuning its parameters. Moreover, the secondary side's active power may be corrected to create a unit power factor pickup when the LCC compensation network is implemented. When the system operates at the resonant frequency, there are two benefits for the LCL converter. First, the inverter only provides the load with the active power it needs; second, the primary-side coil's current is unaffected by the load situation. For bidirectional power transfer, an LC compensation network at both the primary and secondary sides is suggested. The two inductors in an LCL converter must typically have the same value. Typically, a capacitor is connected in series with the principal side coil to create an LCC compensation network, which reduces the size and cost of the supplementary inductor. A zero current switching (ZCS) state could be produced by using an LCC compensation network and fine-tuning its parameters. Moreover, the reactive power on the secondary side could be corrected to create a unit power factor pickup when the LCC compensation network is implemented. Power can be made easier. Further phase shift or duty cycle control is typically used to manage the primary-coil current in order to maintain a constant current, which raises the inverter's energy consumption, control complexity, and soft switching situation risk.

## IV. PROPOSED TOPOLOGY AND ANALYSIS

Figure S1 (S4) depicts the proposed double-sided LCC compensation network and associated power electronics circuit components. On the primary side, there are four power MOSFETs. The secondary-side rectifier diodes are D1 through D4. The transmitting and receiving coils' respective self-inductances are L1 and L2, respectively. The primary-side compensation inductor and capacitors are designated as Lf1, Cf1, and C1, respectively. The secondary-side compensating components are Lf2, Cf2, and C2, respectively. The two coils' mutual inductance is incorrect. Here, the compensated coil is subjected to the input voltage (uAB), and the output voltage (uab) is applied before the rectifier diodes. The currents on L1, L2, Lf1, and Lf2 are, correspondingly, i1, i2, iLf 1, and iLf 2. UAB, UAB, I1, I2, ILf 1, and ILf 2 are used to represent the phasor form of the relevant variables in the analysis that follows.

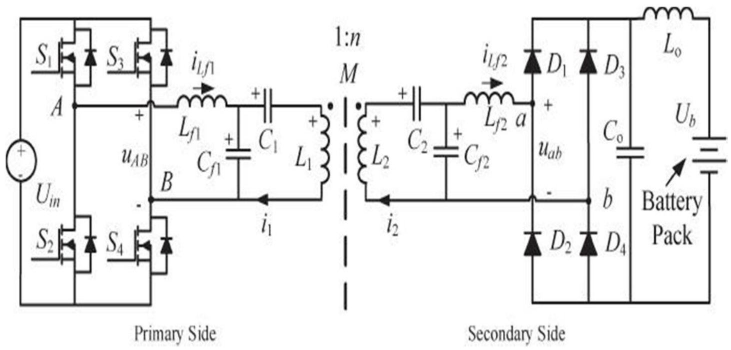


Fig 2: Double sided LCC compensation topology for WPT

## V. RESULTS AND DISCUSSION

The validity and effectiveness of the suggested compensation network have been verified using MATLAB/SIMULINK.

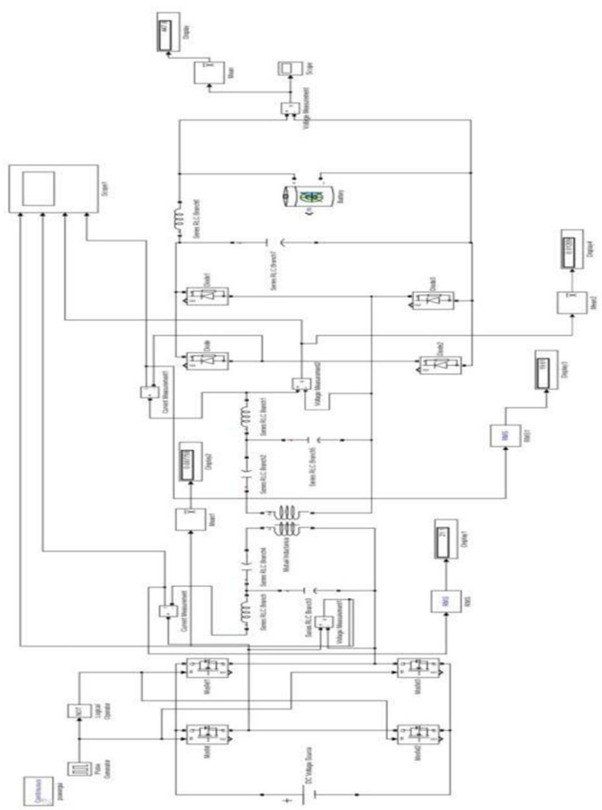

Fig 3:Simulink model of the proposed topology

## VI. SUMMARY AND CONCLUSION

A double-sided LCC compensation network and its tuning technique are suggested in this thesis. The ZVS requirement for the MOSFETs is then achieved due to the ovel topology and tuning technique, which guarantees that the resonant frequency is independent of coupling coefficient and load circumstances.

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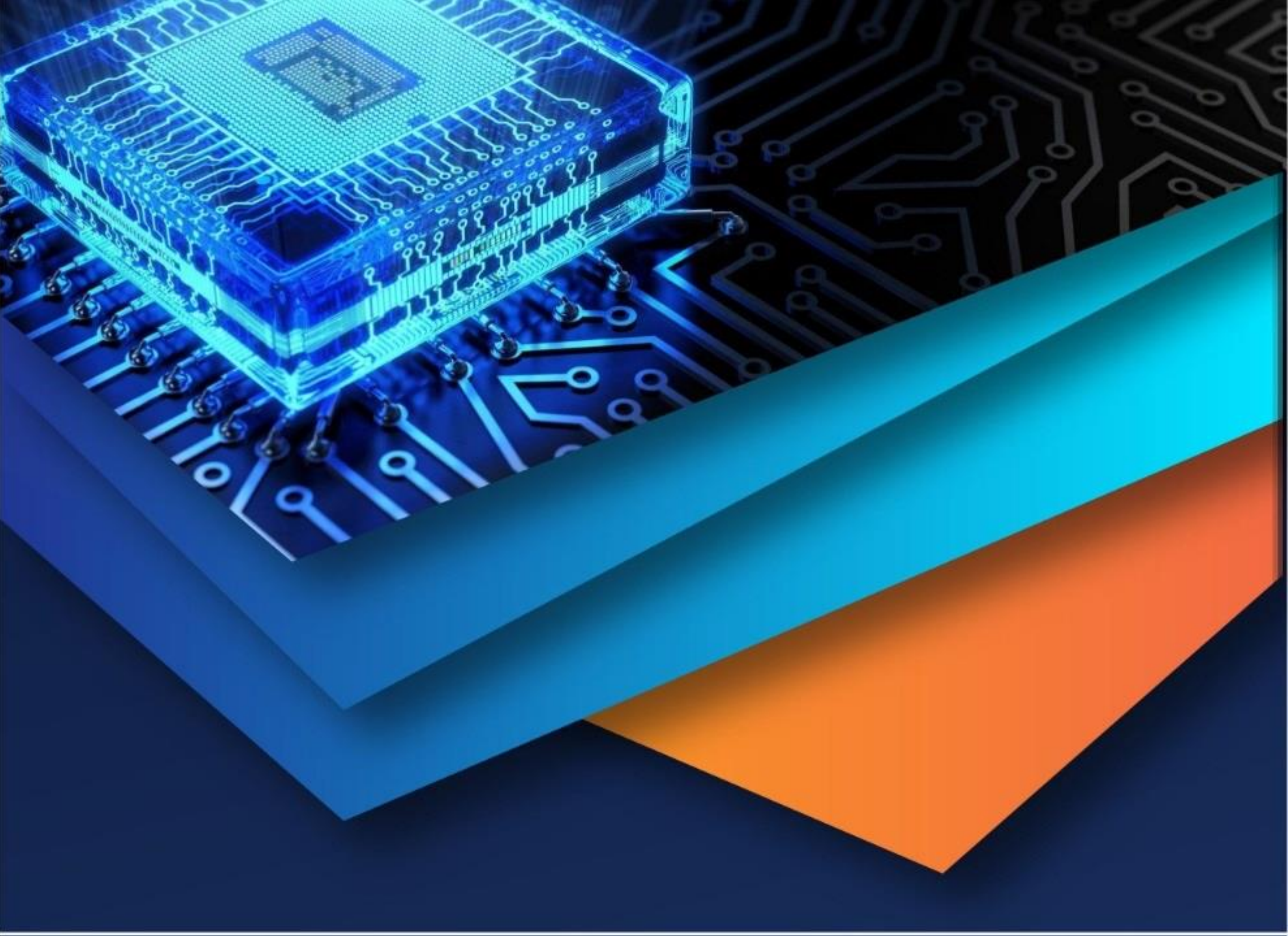

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