

Auto resonant wireless power transmission system

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In the 19th century, Nikola Tesla managed to transfer energy without wires over an air gap between two axially aligned coils using magnetic fields. This achievement marks the birth of the research and development of wireless energy transfer systems, a technology which has not seen a considerable growth during the last few decades though the researchers had their big eye on this topic.

In this project the technique of efficient WPT over short distance, using resonance inductive coupling has been researched. It will be widely useful in EV charging, aerospace and structural health monitoring. Further, this research is conducted to eliminate the drawbacks of existing wireless technology while introducing the auto resonance WPT as a solution. As the resonance conditions of the two coupled system can vary with the geometries of transmitters, environmental conditions and the distance between transmitter and the receiver. Auto resonance is a better solution for these deviations in real world applications.

Initially, the study on wireless energy transfer was conducted using resonance inductive coupling. The main steps carried out were implementing the resonance inductive coupling circuit, analyzing the circuit using different coil geometries, identifying the issues related to efficiency and frequency of WPT system and the solution to overcome the challenges in a practical environment.

The planar spiral and helix coil geometries were tested with the capacitor coupled resonance inductive coupling circuit and the circuits were analyzed with the power transmitting and receiving capabilities for different loads with the air gap between the transmitter and the receiver. In the practical implementations, remedies were taken to minimize the variations between the theoretical and practical system the issues related to transmitting power, frequency range and efficiency. The efficiency of the helix coil is higher than the planar spiral coil along the distance.

In the auto resonance system, the three resonant point indication methods are communication based indication, impedance based indication and variable capacitor based indication. The communication based indication was implemented by developing an algorithm to recognize the peak received power in kHz range (resolution up to two decimal points) and resonance frequency was found. This resonant frequency is chosen to transfer power in the available conditions. The communication is done through a different link until the resonant point of the system is verified. The theory based on impedance based method is, at the resonance point impedance of any system becomes real. Hence, phase shift between voltage and current waveforms is zero. This condition is checked using a phase lock loop circuit. Controller circuit is also used in the design. When the above conditions are satisfied, power is transmitted at the resonance. In the third method, the variable capacitor based indication; a variable capacitor at the receiver is adjusted according to the coupling with the transmitter. This method can be used to have multi receivers with a single transmitter. The capacitor changes it's capacitance to match with the resonance frequency. This method will be significant in most industrial applications.