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Optimal Frequency for Optimal Performance and Efficiency of a Single-Phase Wireless Power Transmission System

Wireless Power Transmission (WPT) systems are growing in popularity to provide contactless solutions to supply power to electronic devices which include smartphones, robots, and Electric Vehicles. These systems have their limitations which prevent them from transmitting efficient energy over long distances and require good design parameters to ensure maximum transmission of power which include wire thickness, size of the transmission and receiving coils, and placement of the coils. Another issue is a physical phenomenon, known as the Skin Effect, which affects conductors that have Alternating Current (AC) signals flowing through them which can reduce the effective cross-section area of the conductors by increasing the frequency of the AC signal which will increase the total equivalent series resistance and will lead to power losses. Finally, WPT systems use coils to transmit power wirelessly which are non-ideal which will lead to lower efficiency and performance. This can be improved by optimizing the Quality-factor (Q-factor) which can maximize the efficiency and performance of a WPT system and is defined as the ratio of inductive reactance of the coils to the total series resistance. Increasing the frequency of the AC signal can increase the Q-factor, but will also increase the total series resistance because of the Skin Effect. Therefore, this research will be conducted to determine the optimal parameters of a WPT system based on determining the optimal frequency to obtain the maximum Q-factor and efficiency by analyzing, and testing a hardware and software implementation of a WPT system by using three different coil designs and while supplying power to a 5 W test load the distances between the transmitter and receiver coils will be varied and the efficiency will be measured for each design at varying frequencies. The three coil designs include one circular coil with a 4 in. diameter, and two rectangular coils with side lengths of 2 in. and 4 in. using 14 gauge wires.