However, EV wireless charging systems include drawbacks. Power transfer (WPT) is an innovative approach using the magnetic resonance coupling of air core transformers. However, EV wireless charging systems include drawbacks caused by the air gap distance between the coil and the car’s battery (load), which reduces efficiency.

A WPT system provides an improving means for static and dynamic charging. The LCC converter proposes a WPT charging system that enhances the performance of electric vehicles. [2] Electric vehicles possess downsides such as long charging periods, high cost, and short battery life cycle. The proposed LCC resonant converter utilizes ZVS and ZCS switching techniques to reduce passive components switching power loss. A dual-sided LCC converter is an effective technique to transfer power between air-gap and separated coupled coils. [3] The implementation of wireless power transfer technology utilizes power transmission through inductive coupling between the transmitter and receiver coil’s magnetic field.

From design perspective, a dual-sided LCC converters contains a transmitter and receiver coils between a primary and secondary resonant tank. Furthermore, the resonant inductors contain lower inductance than magnetized coils [5]. In a dynamic EV charging system, the mutual inductance of the coils proportionally to the coils’ alignment changes, which can hinder inductive power transfer. A frequency controlled dual-sided LCC converter can yield to 96% power efficiency and constant output voltage even during dynamic condition [6]. The dual-sided LCC converter design strives to achieve a 3.3kW power rating and constant 400V output.

The above shows plots of LCC converter gain across various switching frequencies under different k and load values. Moreover, each plot identifies three frequency regions that enable ZVS operation. The designed dual-sided LCC converter’s coupling coefficient is \( k = 0.25 \). The converter in the secondary region is at low gain at 85kHz switching frequency for load resistances of 60-200 ohms [5]. In both regions I and III where ZVS occurs, the converter performances are independent of load resistances. The PID controller IDE coded in CCS to implement to feedback control system in C-programming. The PID passes voltage error with certain frequencies that get saturated at two potential frequency ranges of region I & III. If the operation frequency value measures a greater value than 70kHz, the select switching pass the value. Then, frequencies values of region II saturate by an additional saturation block of 65-70kHz [2]. The final selection of frequencies passes only for gain values greater or equal to 1. Voltage SetPoint is the desired output value, and Error is the difference between the Setpoint and Output. The Error is used to calculate the PID terms and then feeds into the Plant, which is the PWM controller for the H-bridge.

The next step was to create a test environment to implement and verify the feedback control system as well as the functionality of the ADC. The process was to input the PWM signal generated by the DSP into the Arduino board. Using the saturation block, the output frequency was limited to 1.6-2.6kHz. This was so that the Arduino board would be able to read the signal at a lower frequency.

The frequency is defined in an array of 1.6-2.6Hz. The map() function defines a linear relationship between the frequency and a variable voltage. For example, 1.6kHz corresponds to 0V and 2.6kHz corresponds to 3.3V. Any output frequency between this range will then get mapped to a variable voltage. The output voltage will then get fed back to the DSP.

**Summary/Conclusions**

In conclusion, the study addresses a need for WPT charging system that enhances the performance of electric vehicles. Electric vehicles possess downsides such as long charging periods, high cost, and short battery life cycle. A WPT system provides an improving mean for static and dynamic charging. The proposed dual-sided LCC resonant converter modeled to achieve 85Hz resonant frequency alongside ZVS and ZCS switching techniques for reduction of switching power loss [5]. The dual-sided LCC converter frequency controller regulates the operating frequency ranges between two load independent regions of 65-70kHz and 108-120kHz based upon selections of frequencies with gain greater than 1. The Simulink frequency controller model simulates encouraging results of constant 40V, but the max power rating was 784W, which is below the desired Further PID control tuning and studying the performance of a practical model could provide future hints on better performance [6].

**Key References**


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