Wireless charging system with intermediate coils for electric vehicle battery charging system

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Abstract- The destruction of fossil fuel supplies, as well as potentially catastrophic changes in environmental circumstances, are threatening the increasingly global economy. Besides that, it has sped up the development of It has also accelerated the development of ecologically friendly technology, resulting in breakthroughs in major sources of carbon dioxide emissions, such as transportation. To help mitigate the environmental damage caused by carbon-based fuels, electric vehicles (EVs) are becoming more popular as a viable alternative to gasoline and diesel automobiles. Aside from that, the market for electric cars (EVs) provides humanity with a new option to extend the life expectancy of transportation at a cheaper cost than was before accessible to them. In this study, an electric car charging technique that makes use of intermediate coils is detailed, and the data indicate that the results achieved are superior to those obtained by using fewer coils in the previous approach reported before. The results produced are superior to those obtained by utilising fewer coils in the earlier approach described before, according to the findings.

Keywords- Electric Vehicle, Coils, MATLAB, Simulation, Electrical

I. Introduction

Operations in the construction sector, transportation, commerce, and a wide range of other activities are among the different sorts of energy-efficiency endeavours [1-2]. Laptop-based entertainment connections, including to laptops and mobile phones, as well as portable personal computers, are becoming more popular. A significant amount of study and analysis is thus required on this issue [3]. The relevance of electric cars for hybrid energy storage systems would be incorporated in a more focused understanding of the perspectives of electric vehicles. [4]. It is becoming clear that the depletion of fossil fuel reserves, as well as possibly catastrophic shifts in environmental conditions, pose a challenge to the growing global economy [5]. It has also spurred the development of sustainable technology, which has resulted in improvements in significant carbon emitters such as transportation [6-8]. Batteries and power shaping technologies, as well as their limitations, have historically prevented electric cars from attaining widespread adoption and commercial success. [9] But in recent decades, BT has been developed to have a high energy density while also being lighter and more efficient [10], as well as a reduced total weight. Furthermore, when used in conjunction with an appropriate power shaping circuit, an efficient energy storage device has the potential to improve overall performance even further. Academics and businesses are investigating power conditioning topologies that have reduced power losses, longer lifespans, more trustworthy energy transfer, and greater charging-discharging cycles [11]. For short driving ranges, efficient, rapid chargers are now being employed when there is a concern about human health and safety, as well as for long driving ranges. For electric vehicles (EVs) operating in both the stationary and dynamic modes of operation, inductive power transfer (IPT)-based typologies are now being employed to offer safer battery charging (BC) solutions [12-16]. The selection of a converter is thus essential in influencing the flow of electric vehicles (EVs) into the market. [17] As a consequence, it effectively contributes to the elimination of environmental issues created by transportation difficulties. The wireless charging procedure protocol is shown in Figure 1. However, although it is feasible to achieve ZVS by optimising traditional series compensation, it is conceivable to achieve ZCS by using an auxiliary network [18-20].

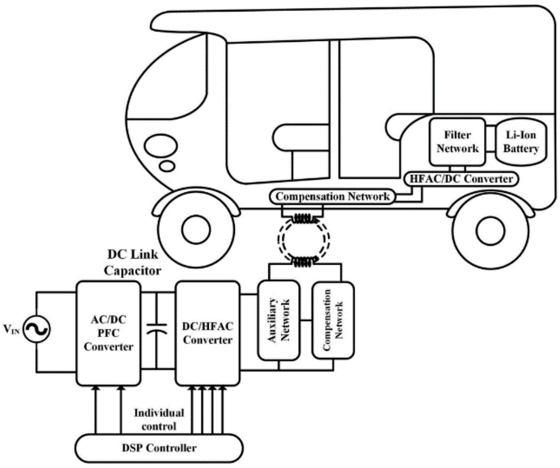

Figure 1: Wireless charging protocol

II. Literature Review

Electric cars offer a number of benefits, but the negative repercussions of continuing to depend on fossil fuels for transportation are the primary drivers for transitioning to electric mobility. [1] [2] If the supply of oil is disrupted, the price of oil will increase, and the economy would become unstable as a result. As a result of human activity, a significant percentage of the world's original crude oil reserves has already been depleted, resulting in a scarcity of crude oil. [4] Crude oil consumption is predicted to grow in lockstep with increasing car ownership rates practically wherever you look in the coming years. Increasing numbers of people are becoming aware that fossil fuels will become more unreliable in the future and that we will need a stable alternative energy source to power transportation [5, 6].

The general public has access to a diverse variety of power production alternatives, including environmentally friendly options like as wind, solar, and hydrostatic generation, as well as conventional ones. [6] Given the fact that energy may be created in a number of different methods, there is less chance of a disruption in power supply [7]. The National Renewable Energy Laboratory estimates that the efficiency of converting stored energy to mechanical energy for electric propulsion is on the order of 80 percent, while the efficiency of internal combustion is at most 30 percent [8]. [9] When compared to gasoline, electricity is far less costly, and its costs are more predictable.

When it comes to transportation, the difficulties associated with storing electrical energy for use in automobiles exceed the benefits of electrification in this area. Buyers are willing to purchase electric vehicles if they provide the same or better performance, range, and service life as conventional gasoline-powered automobiles at a price that is equal to or less expensive than the price of gasoline-powered automobiles [10], as long as the price is equal to or less expensive than the price of gasoline-powered automobiles. In today's world, there are a variety of feasible options for storing electric energy, including fuel cells, ultra-capacitors, and several other forms of batteries. When it comes to these exact parameters, none of these alternative fuels can currently compete with gasoline on their own terms. [11] Governments and consumers are getting increasingly interested in cars that are more fuel efficient and release less emissions. It is certain that the automobile sector must adapt to meet this increasing demand for its products. Initial efforts were made to address this issue in the early 1970s [12].

Automobiles with electric drivetrains are becoming more common, with hybrids and all-electric vehicles set to come in the not-too-distant future. There are a number of technical difficulties to reckon with as a result of this decision. Here are a few examples of how this might happen. It is critical to include electrical energy storage as a factor in long-distance transportation [14]. The most significant of these difficulties is the most hardest to complete since it is the most time-consuming [15]. Various methods of storing electricity are available, including fuel cells and batteries, each with its own set of advantages and disadvantages[15]. A decent balance between having enough energy storage to allow for an acceptable electric-only range and having enough power capabilities to give enough acceleration and deceleration [16] is challenging to achieve.

It is possible to maximise the benefits of two separate storage technologies by using a hybrid energy storage device, which combines the advantages of both methods. Combining the advantages of two different types of energy storage devices, hybrid energy storage systems are able to provide the best of both worlds. Several technical, design, and evaluation requirements for hybrid electric energy storage are examined in this study, as well as the ramifications of these requirements.

III. Implementation

Wireless power transfer (WPT) is becoming more popular as a topic of discussion. Despite the fact that WPT has been in existence for more than a century, the WPT industry has only lately started to see significant growth and development. According to a recent estimate, the number of publications on wireless power has increased by at least 1200 percent [1] since 2000. Present-day solutions are seeing significant success in the marketplace, with concepts moving quickly from innovators to early adopters. The present solutions, on the other hand, are mainly concerned with producing a "nice" impression, and in most cases, they do not place a high value on user ease [2]. Naturally, a real-world application is necessary for normal customers who are not well-versed in technical matters and do not keep up with the most recent technology advances. Evaluation and development of wireless power transmission technologies, as well as the physics that underpins them, were among the project's aims. The fundamental objective of the project was to design and execute a wireless energy transmission system prototype, as well as to include it into the Next Floor's innovative floor.

Active switches S1 through S4 on the main side and diodes D5 through D8 on the secondary side combine to generate an H-bridge on the main side (conventional). At the input, Ca1 and Ca2 also function as potential dividers, working in concert with the auxiliary components LA and TA in order to maintain the soft-switching feature of the circuit when BC is present. L1 and L2 link it to C1 and C2 on the main and secondary sides of the circuit, respectively, on the main and secondary sides of the circuit. According to [3,] the operation of the converter is controlled by the application of MPWM. A few assumptions must be examined in order to completely appreciate the working principle of the converter that has been recommended. Additionally, in addition to the internal switch diode and capacitance, all active and passive devices, such as transformers, direct current sources, switch diodes, and capacitors, are deemed to be perfect. It is not taken into account the resistance of the inductor in series with the transformer and the capacitance of the transformer's interwinding. Figure 2 depicts the first circuit configuration.

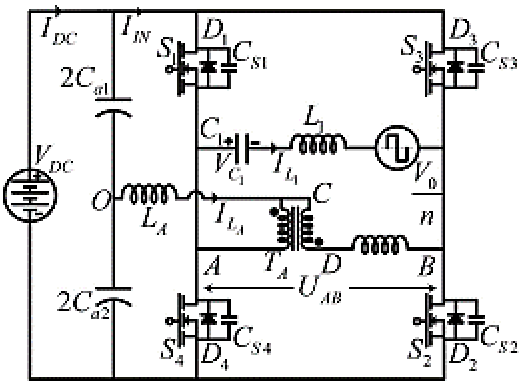

Figure 2: Existing Topology [1]

Figure 3 shows the proposed topology with intermediate coils. A H-bridge is formed by active switches S1 through S4 on the main side and diodes D5 through D8 on the secondary side (conventional). Ca1 andCa2 serve as potential dividers at the input of the circuit, in conjunction with auxiliary components LA and TA, in order to retain the soft-switching characteristic of the circuit with BC. It is connected to C1 and C2 on the main and secondary sides of the circuit, respectively, by L1 and L2.

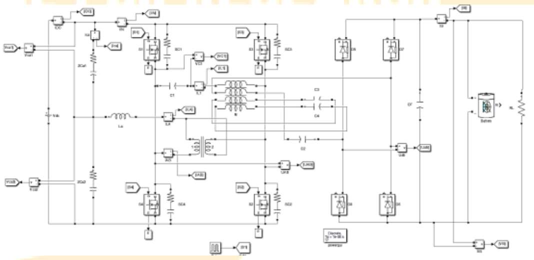

Figure 3: Proposed Topology with Intermediate Coils

A few assumptions must be examined in order to completely appreciate the working principle of the converter that has been recommended. Additionally, in addition to the internal switch diode and capacitance, all active and passive devices, such as transformers, direct current sources, switch diodes, and capacitors, are deemed to be perfect. It is not taken into account the resistance of the inductor in series with the transformer and the capacitance of the transformer's interwinding. 3) The voltage divider capacitors (Ca = Ca1 = Ca2) and the common-mode filter (CF) are large enough to guarantee that the voltage at the converter's input and output terminals remains constant during the operation. Fourteenth, the effects of TA's magnetising inductance are not taken into account

So the switch S1 is activated with ZVS right before the time instant t0, due to the lagging current (IL1 + ILA) that already exists between the switches D1 and S2, and which flows between the switches D1 and S2. In addition, a potential difference between AC and CB is created, as is current flow between the two circuits.

I_{L_A} start rising from $I_{L_A(t_0)}$

$$\left.\begin{array}{r} i_{L_A} = \\ \dfrac{|V_{C_{a1}} - V_{C_{a2}}|}{2L_A} T_{\mathrm{ON}} - i_{L_A(t_0)} \\ |V_{C_{a1}} - V_{C_{a2}}| = 0 \,||\, i_{L_A} = 0 \end{array}\right\} \begin{array}{l} \text{If} \rightarrow R_{ON(S_1-S_4)} \neq 0 \\ \\ \text{If} \rightarrow R_{ON(S_1-S_4)} = 0 \end{array} . \quad (1)$$

S1 is conducting prior to time zero (t0), and the switch current differential (iS1 iS2) is flowing from time zero (TA), as shown by the equation (ITA1 + ITA2 = ILA). In both sites A and B, KCL is being used, along with other low-energy saving measures.

$$i_{C_{S1}} + i_{C_{S4}} = i_{T_{A2}} + i_{L_1}$$

$$2i_{C_{S1}} = i_{L_1} + \frac{i_{L_A}}{2}.$$

As soon as this mode is started for the first time, S1 is switched off if S3, S4, and S5 have already been turned off and S2 is still conducting. The dominant inductance L1 is now isolated from the dc power supply, and IL1 + ILA 2 begin charging the switch peracetic capacitor CS1 via the dominant inductance L1. The dominant inductance L1 has been disconnected from the dc power source. VCS1 makes contact with VDC at the eleventh moment (t11). The path of IL1 is revealed after the 11th time step, as a result of a change in the ILA equation. As a consequence of this change being rejected by the inductor LA, CS4 is discharged, resulting in a current flowing from S2 to S4 via the capacitor CS4. As a result of the freewheeling, when the voltage of CS4 reaches zero, D4 turns on, causing the decrement of IS2 to zero or ZCS for switch S2 to occur.

IV. Results

The results for the implementation are presented in this section for the existing and proposed work as follows.

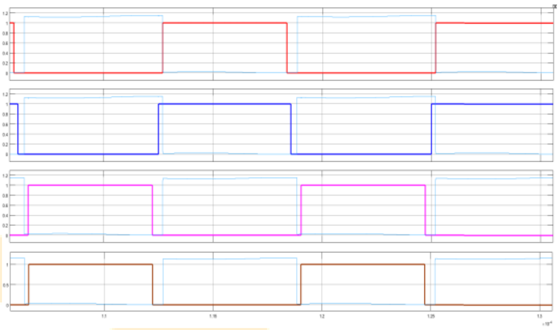

Figure 4: Pulse Inputs

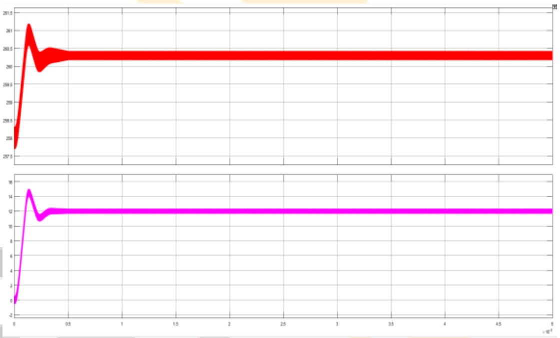

Figure 5: Output Existing VB and IB

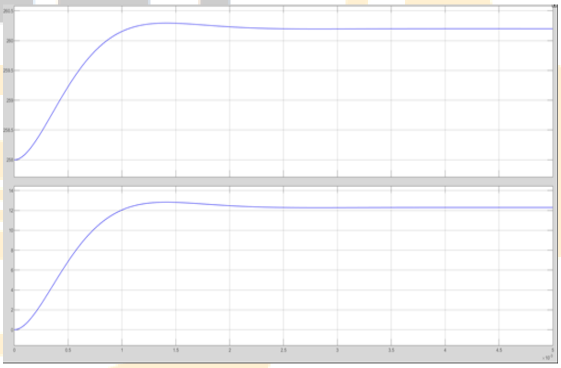

Figure 6: Output Existing VB and IB

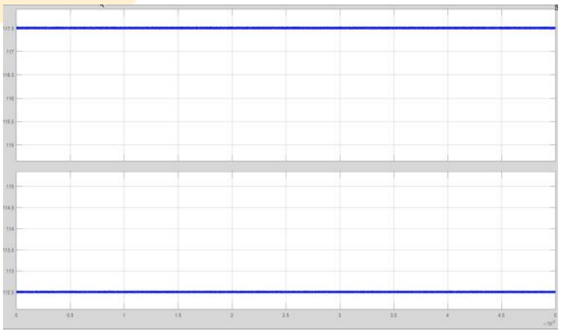

Figure 7: Output VB IB for Proposed Topology

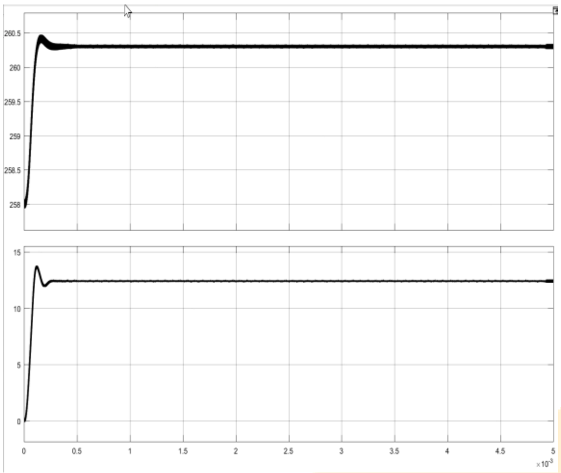

Figure 8: Output VB IB for Proposed Topology

As seen in figure 7 and 8, the settling time is better and less distortions as shown in figure 5 and figure 6.

V. Conclusion

As a result, when employing the intermediate coils idea, a greater output of wireless charging is obtained, as is less noise and less settling time, all of which contribute to a longer lifespan of the electric vehicle and the components connected with charging. As a result of the success of such systems, researchers have focussed their efforts over the past decade on developing systems that are more tolerant of misalignment and are capable of managing the variations in coupling that arise as a result of misalignment. Because of this, advances in magnetic design and power regulation have been made, allowing for the development of practical EV charging systems for stationary charging systems that do not need alignment aid. However, dynamic power transfer to EVs on the go continues to be an issue.

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