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Design and Implementation Efficient Topology for Electric Vehicle Battery Charging For Charging Station

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Abstract *– As a direct result of the success of such systems, researchers have focused the majority of their efforts over the last ten years on developing systems that have a higher tolerance to misalignment and are able to handle the variations in coupling that occur as a direct result of this misalignment. This has resulted in advancements in magnetic design and power regulation, which has made it possible to consider practicable electric vehicle charging systems for stationary charging systems without the need for alignment assistance; however, the transmission of dynamic power to electric vehicles that are in motion continues to be a cause for concern.*

Keywords *Hybrid Electric Vehicles, Wireless Power Transfer, Electric Vehicle*

I. Introduction

When General Motors created the world's first electric vehicle in 1996, it marked the beginning of the road travelled by electric automobiles. Since then, electric cars have become more popular. Since then, electric cars have seen increased levels of market penetration. Tesla designed and constructed the Wardenclyffe Tower with the goal of wirelessly transporting electrical power around the globe via the ionosphere. This would eliminate the need for cables. Despite this, the idea has not seen significant expansion in terms of additional development or marketing due to the constraints imposed by technical limits (such as a lack of overall system efficiency). In subsequent years, throughout the 1920s and 1930s, magnetrons, devices that transform electric current into microwaves, were developed. Because of this, it became feasible to transmit electricity wirelessly across a larger distance than had been conceivable in the before. However, prior to 1964, it was not understood how microwaves might be converted back into a form of energy. W. C. Brown, who discovered this discovery with the use of rectenna, is responsible for making this a reality.For the purpose of demonstrating the practicability of this kind of power transfer, Brown used microwave radiation to power a model aircraft. This discovery was the impetus for a number of experiments that were conducted during the 1980s and 1990s in Japan and Canada on the use of microwave power in aircraft [1]. More recently, various consortiums have been created in order to set international standards or wireless charging.

These consortiums include the Wireless Power Consortium [2], the Power Matters Alliance and the Alliance for Wireless Power [3]. [4] These days, the standards are employed in a significant portion of the products that are offered for sale in the marketplace.

Despite this, the producers of electric cars have embarked on a great path with the support of Chevrolet and Nissan. Both the breakthroughs in technology that have been achieved and the consumers' willingness to accept the product despite the fact that it does not have a negative influence on the environment have made this a possibility. The acquisition of an electric vehicle (EV) is widely seen as a significant move toward the protection of the natural world, the extension of the useful life of transportation, and the reduction of reliance on petroleum. All of these goals may be achieved with the use of a single investment. Because of this significant advantage in comparison to their competitors, an ever-increasing number of automobile manufacturers have recently begun making significant expenditures in.

II. Implementation

On the primary side of an H-bridge are the active switches numbered S1 through S4, and on the secondary side are the diodes numbered D5 through D8 (conventional). In addition, components Ca1 and Ca2 execute the job of a potential divider at the input with auxiliary components TA and LA in order to maintain the soft-switching quality of the circuit with BC. This is accomplished with the help of auxiliary components TA and LA. Using the appropriate components, L1 and L2 are connected to the circuit's primary and secondary sides, respectively, using the components C1 and C2. The regulation of the converter's operation is made possible with the use of MPWM in [22].

The following set of presumptions is taken into account in order to get an understanding of the operating principle of the converter that has been proposed.

1) Each and every one of the active and passive components, such as a transformer, a DC source, switches, diodes, and capacitors, in addition to the internal switch diode and capacitance, are in excellent working order.

2) The electrical series resistance of the inductor as well as the inter winding capacitance of the transformer are not taken into consideration.

3) The voltage divider capacitors (Ca = Ca1 = Ca2) and the CF capacitor are both large enough to guarantee that the input and output terminals of the converter maintain a constant voltage.

This is accomplished via the use of a voltage reference.

The effects of TA's magnetising inductance are disregarded, which is problematic with regard to issue number four. Performance characteristics of the convertible device that is being considered depicts the operating principle of the proposed topology in steady state as being divided into eight modes (modes I–VIII), and other one depicts the operational waveforms for those modes.

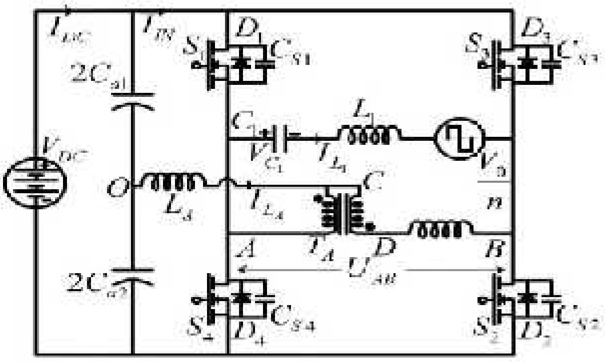

Figure 1 Simplified network with battery load refereed at transmitter coil side

The concepts of those modes are given below:

1) In Mode I (t0 > t > t1), the following occurs: The switch S1 was turned ON with ZVS at the time instant t0 because lagging current (IL1 + ILA) was flowing from D1 and S2 before the time instant t0. In addition to this, a potential difference is generated between alternating current and alternating bias, and current also forms a potential difference between the two.

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

$$i_{L_A} = \begin{cases} \frac{|V_{C_{a1}} - V_{C_{a2}}|}{2L_A} T_{ON} - i_{L_A(t_0)} & \text{If} \rightarrow R_{ON(S_1-S_4)} \neq 0 \\ |V_{C_{a1}} - V_{C_{a2}}| = 0 \mid i_{L_A} = 0 & \text{If} \rightarrow R_{ON(S_1-S_4)} = 0 \end{cases}.$$

2) In Mode II (t1 > t > t2): Prior to the time t0, the switch S1 is in the conducting state, and the switch current difference (iS1 iS2) is being supplied by TA (ITA1 + ITA2 = ILA). KCL calculations are done at sites A and B, and minimal energy conservation is used.

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

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

At the beginning of this mode, S1 is switched OFF, even when S3, S4, and S2 have both previously been set OFF. S2 continues to conduct. The dc power supply to the dominating inductance L1 has been disconnected, and the charging of the switch peracetic capacitor CS1 has begun thanks to IL1 and ILA 2. At the time t11, VCS1 will have arrived at VDC. Following the t11 checkpoint, IL1 locates a solution by inducing a change in ILA. This change is resisted by the inductor LA, and as a result, a current is created that flows from S2 to S4, which discharges CS4. D4 switches on after the voltage on CS4 has reached zero, and this freewheeling causes the decrease of IS2 until it hits zero, which results in ZCS for switch

$$t_{(V_{C_{S1}}=V_{DC})} = \frac{\frac{1}{2}C_{S3}V_{DC} - \left(i_{L_1(t_{1-})} + \frac{i_{L_A(t_{1-})}}{2}\right)}{i_{L_1(t)} + \frac{i_{L_A(t)}}{2}}.$$

3) The Mode III (t2 > t > t3): When all of the other switches are already off, entering this mode begins when the S2 ZCS is turned off. After reaching its positive peak, the current ILA will begin to decrease until it is zero during this mode. At the same time, the peracetic capacitor CS2 will begin to charge till the time t21 up to VDC. After the time t21, the current IL1 + ILA 2 finds its course by discharging the capacitors CS3, CS4, and turning ON the diodes D2, D4.

$$t_1 > 2C_{S1}\frac{V_{DC}}{i_{L_1(t_0)} + \frac{i_{L_A(t_0)}}{2}}.$$

The voltage stress across switch is given by expression:

$$v_{S1} = V_{DC} + v_{C_1}$$

$$v_{S4} = -v_{C_1}.$$

4) Mode IV (t3 > t > t4): In this mode of operation, S4 is turned ON with ZVS as long as D4 is on, and the voltage across S4 is very close to zero. After reaching its lowest point, the auxiliary inductor current known as ILA

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is beginning to linearly increase in a direction toward a higher positive value.

5) Mode V ($t4 \leq t < t5$): When in this mode, both ZVS and S3 are activated. IAB immediately begins to take on the form of a sinusoidal wave, and the voltage across S3, S4 becomes zero as soon as its route is finished.

6) Mode VI ($t5 > t > t6$): This mode begins with shutting OFF S3, which then causes CS3 to begin charging up to VDC att51. After reaching its maximum value and IL1, the auxiliary inductor current ILA has begun to decline, which compels IS4 to decrease in preparation for the ZCS turn-off situation.

7) Mode VII ($t6 \leq t < t7$): In this mode, S4 turned OFF at ZCS and VCS4 rises up to VDC at t61. After t61, ILA starts incriminating in positive direction. The diodes D1 and D2 turned ON and power is feedback to the source.

8) Mode VIII ($t7 \leq t < t8$): During this mode of operation, switch S2 is turned ON with ZVS and current shifts from D2 to S2. During mode, I to VIII constant voltage and current are maintained in the battery.

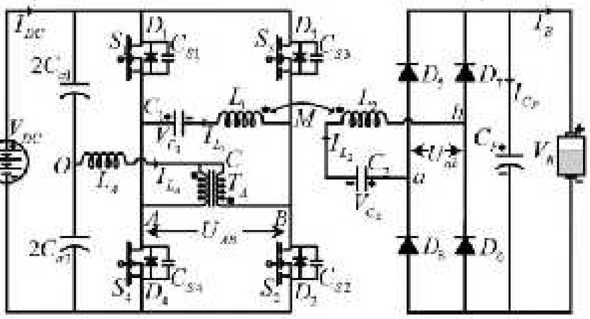

Figure.2: Existing Topology

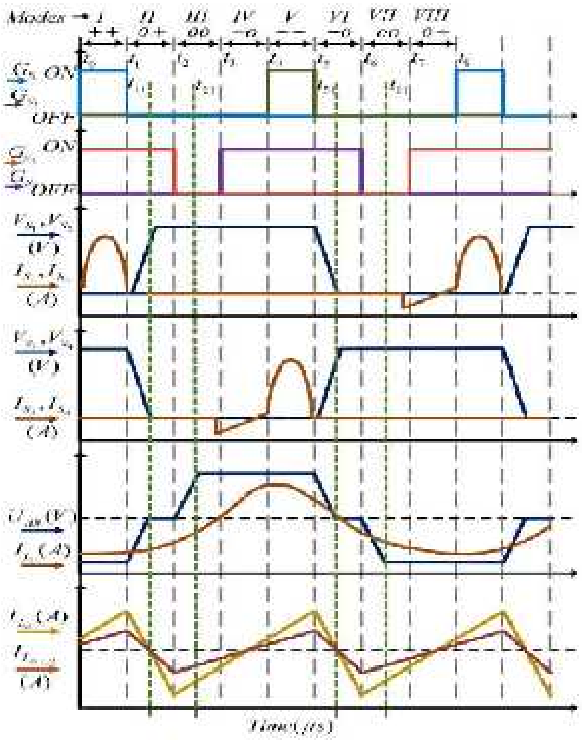

Figure 3: Theoretical operating waveform of proposed wireless converter Topology

III. Result

The results for the implementation are presented in this section for the proposed work as follows. The comparative parts of existing and current work are in later part of this.

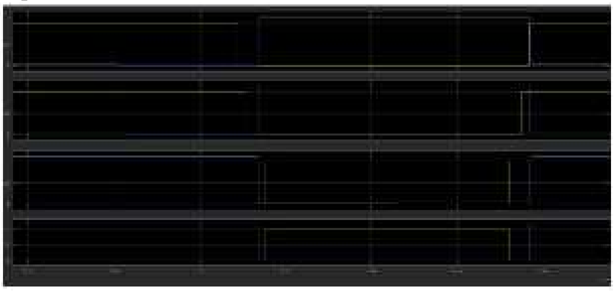

Figure 4: Pulse Inputs; Vs1 & Vs4 (Time-μ sec)

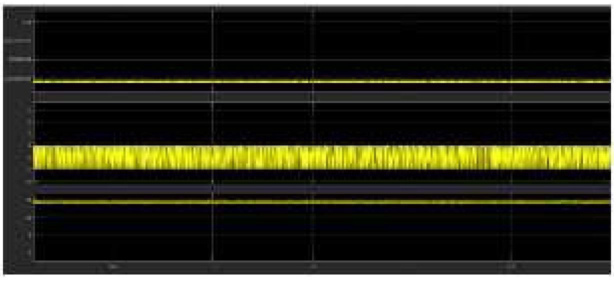

Figure 5: Saturated Vc1(V) & Vc2(V), IIN(A), IDC(A)

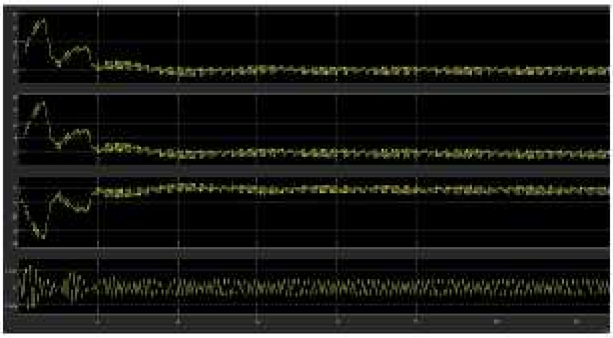

Figure 6: Current through Ancillary inductor ILA(A) and VC1(V)

Figure 7: Voltage across capacitance of input dc link capacitor (Vca1&Vca2)

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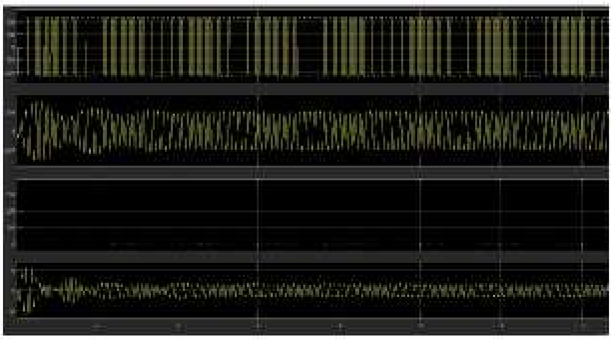

Figure 8 : RMS value of voltage across A & B and a & b ICA(A), IL1(A)

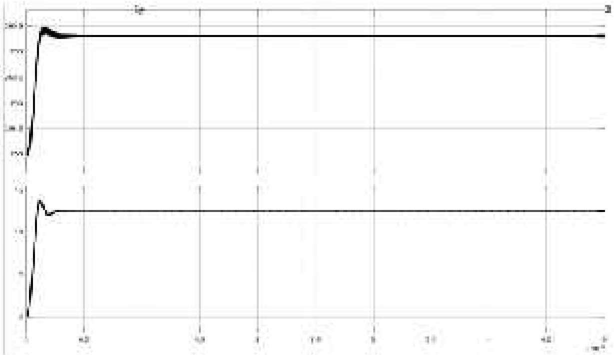

Figure 9: Output Voltage(VB) and Current(IB) across battery v/s Time(m sec.) for proposed topology without Load

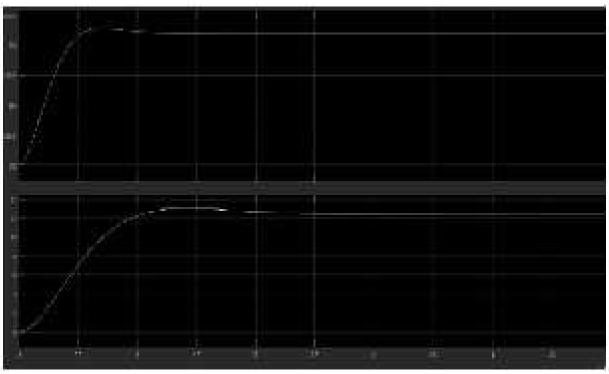

Figure 10: Output Voltage(VB) and Current(IB) across battery v/s Time(m sec.)

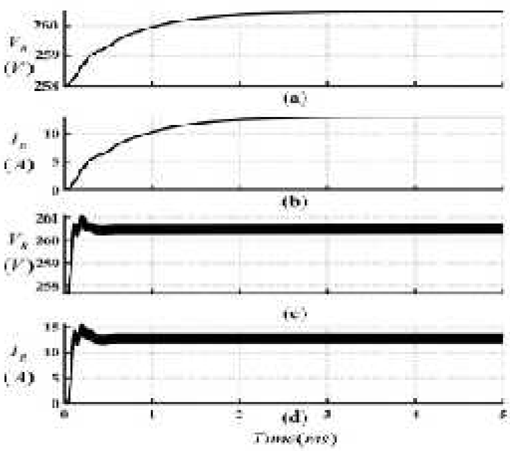

Figure 11(a): Different parameters of existing work

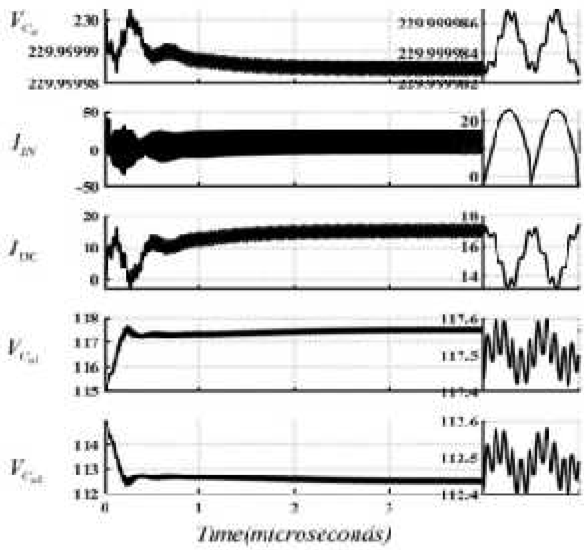

Figure 11(b): Different parameters of existing work

IV. Conclusion

The greater output of wireless charging is accomplished by using the intermediate coils idea. This results in less noise and less settling time being achieved, which in turn enhances the lifespan of electric vehicles and the components connected with charging. Because a strong central processing unit (CPU) is not required any more, the overall price tag may be decreased even further. The theoretical analysis and modelling have been provided so that ZVZCS may be achieved while also reducing the amount of control complexity. The findings of the simulation showed that the proposed topology fulfils the ZVZCS requirement over the whole load spectrum. This was shown by the fact that the criterion was met. The strategy that was suggested led to a reduction in ripple in the input/output voltage and current while at the same time employing a low value for both the dc link capacitance value and the filter capacitance value, respectively. It has been discovered that both a resistive load and a battery load are capable of reaching an acceptable efficiency of 91.26 percent.

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