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AN ADVANCED WIRELESS CHARGING TOPOLOGY FOR EV'S WITH IPT TECHNIQUE WITH LOSS LESS OPERATION

Dr. G. NARESH[1], MALLIPUDI DURGA MALLESWARI[2], GEDELA DINESH[3], SATTI SOFIA SUGANDHI[4], MAMIDI SUNIL KUMAR[5], PATI MANIKANTA[6]
[1]Professor, Dept. of EEE, PRAGATI ENGINEERING COLLEGE
UG Students, Dept. of EEE, PRAGATI ENGINEERING COLLEGE

ABSTRACT

We show a brand-new integrated three-level ac-dc converter. The three-level dc-dc converter and boost power factor adjustment are both integrated into the converter under consideration. Two independent controllers are used to run the converter: an input controller that corrects the power factor and controls the dc bus, and an output controller that controls the output voltage. The input processor maintains a single-stage converter topology while preventing the dc-bus voltage from rising too high. However, achieving ZVS or ZCS for all power switches simultaneously is still a challenging task in IPT systems. In this article, an improved zero-voltage zero-current switching (ZVZCS) IPT topology and its switching pattern are proposed. The proposed concept is verified by using MATLAB/Simulink based simulations for resistive and battery load.

INTRODUCTION

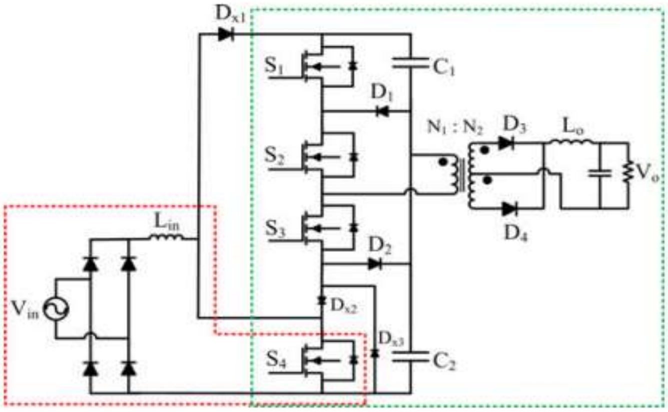
The world's economy is becoming more interconnected, which brings with it a number of challenges, including the depletion of fuel resources and the hazardous disruption of environmental conditions. In addition to this, it has encouraged the development of environmentally friendly technology that have led to advancements in key sectors that are responsible for substantial carbon emissions, such as the transportation sector. As a result, electric vehicles (EVs) are becoming increasingly popular as a solution to the problem of reducing the negative effects that carbon-based fuels have on the environment. In addition, the market for electric vehicles presents people with a brand-new option to extend the life expectancy of transportation at a reduced expense.

In the past, the restrictions that prevented electric vehicles (EVs) from achieving market success were the battery technology (BT) and power shaping technologies. Yet, over the course of the last few decades, BT has evolved to have a higher energy density while also becoming lighter and more efficient. When combined with an appropriate power shaping circuit, an energy storage device that is both efficient and effective can increase the overall performance of the system. Researchers and companies in a variety of industries are working to perfect a configuration for dc–dc power conditioning that has reduced power losses, longevity, dependable energy transmission, and higher charging-discharging cycles.

These days, efficient and rapid chargers are used in situations where there is a short driving range and worries about human safety. In the current context, inductive power transfer (IPT)-based typologies have been embraced as safer battery charging (BC) solutions during both the stationary and dynamic modes of operation for electric vehicles (EVs). In order to reduce the circuit impedance and boost the converter's overall efficiency, compensation networks are offered. On the other hand, the complexity of the configuration is directly proportional to the number of active and passive components that make up the circuits.

The appropriate solution can further improve things like the driving range, the maintenance cycle, the decreased carbon footprint, and the end-user economy. As a result, the choice of converter has a significant impact on the circulation of EVs in the market. As a consequence of this, it provides expert support for the reduction of environmental difficulties caused by transportation-related concerns. IPT topologies that are based on the classical series-series capacitor compensation are among the most preferred network arrangements adopted by industries. This is due to the fact that the structure of these topologies is relatively simple, and their operational stability remains consistent regardless of the distance between coils. This network offers a low-cost solution; nevertheless, it lacks efficiency, the capacity to transfer power, high resonant peaks, and control precision for variable loading. In this paper, an algorithm for phase control is described in order to improve bandwidth efficiency; nevertheless, the expenditure that follows from using such an algorithm as a complex control technique for variation frequency. Defining the control border within the appropriate frequency range helps to alleviate some of the problems that are caused by variable frequency.

The control techniques that are given in and only support clam in order to provide improved efficiency for the IPT system by preserving zero voltage switching (ZVS). The topological improvement was accomplished by utilizing an intermediate L–C series compensated structure at both the transmitter and receiver ends of a new coil support network. This network was used to accomplish the topological advancement. Because of this layout, there is an increase in weight on the vehicle side; however, this is compensated for by placing both coils on the primary side. The method that was described and offered provides support for magnetic flux under misalignment conditions, but at the expense of the elegance of simplicity in computation and control operation. In, the problems that arise when using an isolated tank network to support IPT are addressed by combining an H-bridge high-frequency transformer with a L–C tank network. This provides a solution to the problems that were previously encountered.



Proposed circuit topology

METHODOLOGY

OPERATING PRINCIPLE OF THE PROPOSED CONVERTER Active switches S1 − S4 at primary side and diodes D5 − D8 at secondary side forms a H-bridge (conventional). Moreover, Ca1 and Ca2 act as potential divider at the input with ancillaryLA and TA to maintain the soft-switching feature of the circuit with BC. The primary and secondary side of the circuit is coupled with L1 and L2 with C1 and C2, respectively. The operation of the converter is controlled by using MPWM. The following assumptions are considered to understand the operating principle of the proposed converter. 1) All active and passive devices consisting of transformer, dc source, switches, diodes, and capacitors are ideal including internal switch diode and capacitance. 2) Electrical series resistance of inductor and interwinding capacitance of transformer are neglected. 3) Voltage divider capacitors (Ca = Ca1 = Ca2) and CF are large enough to maintain constant voltage at input and output terminals of the converter. 4) The effects of the magnetizing inductance of TA are neglected.

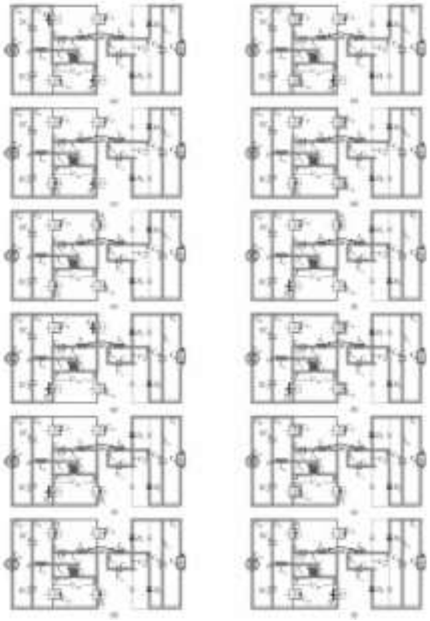


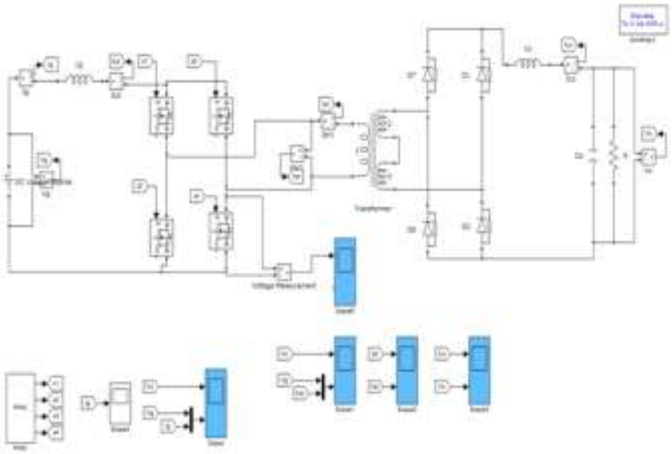
Fig.1: Operating modes of proposed battery charger topology. (a) Mode I (t0 ≤ t < t1). (b) Mode II (part-1) (t1 ≤ t < t11). (c) Mode II (part-2) (t11 ≤ t < t2). (d) Mode III (part-1) (t2 ≤ t < t21). (e) Mode III (part-2) (t21 ≤ t < t3). (f) Mode IV (t3 ≤ t < t4). (g) Mode V (t4 ≤ t < t5). (h) Mode VI (part-1) (t5 ≤ t < t51). (i) Mode VI (part-2) (t51 ≤ t < t6). (j) Mode VII (part-1) (t6 ≤ t < t61). (k) Mode VII (part-2) (t61 ≤ t < t7). (l) Mode VIII (t7 ≤ t < t8).

The idea of Wireless Power Transfer (WPT) is not a new concept. From the end of the 19th Century, Nikola Tesla was already experimenting with the possibilities. The past few decades have seen a revival of the interest in wireless power transfer, with the need for the charging of autonomous electronic devices such as medical implants (1960s,) and the ease it could bring to the charging of portable devices such as laptops and mobile phones (since the 2000s.) At this time, the technology is already in the commercial stage since the launch of the ”Qi” standard by the Wireless Power Consortium, of more than 130 worldwide companies . Electric vehicles (EVs) have recently brought a substantial new importance to the WPT technology. The different methods of WPT can be divided either based on the range of their transmission, or by the principles upon which they are realized. Under the latter division, WPT methods are categorized as radio frequency, electromagnetic induction, and magnetic resonance coupling.

One example of a medical implant is a cardiac pacemaker The pacemaker is an electronic medical device used to control the rhythm of the heart. It provides electrical impulses which maintain the regular rate of a heartbeat. Such a device requires a continuous supply of power, and the non-feasibility of charging through wires is obvious. Wired charging, if possible, is hazardous, expensive, and inconvenient. Current pacemakers are operated by an embedded battery, which has limited life and size limitations, and for which wireless power transfer would offer a charging solution.

With WPT Systems WPT systems, as has been shown above, are far more complex systems than the conventional plug-and-socket systems of wired charging. Other than this comparable complexity, WPT have the disadvantage of lower efficiency, higher cost, limited flexibility, and the safety concerns from the present magnetic fields. Other problems with WPT systems are presented below. Foreign and Live Objects (FO/LO) The idea of transferring power through air via magnetic fluxes comes at the risk of the electromagnetic field being absorbed by nearby foreign (metallic) or live objects. Not only does this result in losses by requiring the primary to transmit higher levels of power, but the risk these scenarios can introduce is in the considerable heating of the intrusive bodies. Even systems of power transmission of as low as 5W can heat objects to levels unaccepted by the ISO safety standard levels. It has been shown that power dissipated in metal objects like a coin (figure 2-11,) metalized pharmaceutical wrapping, a paper clip, or a gold ring, as low as 0.5 to 1W can heat the object to temperatures above 80◦C.

SIMULATION RESULTS



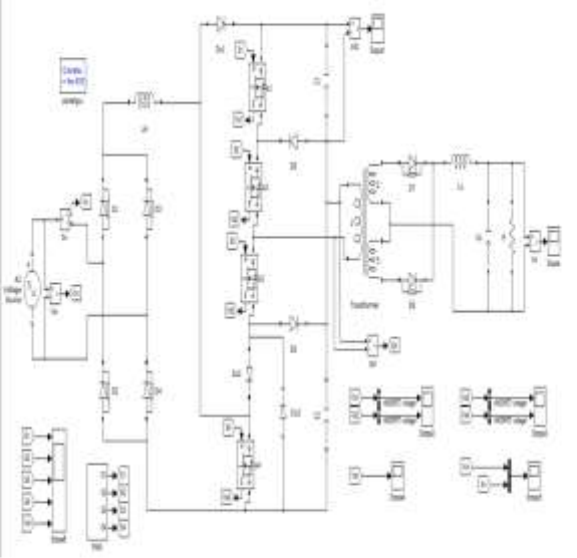


Fig 1 simulation circuit

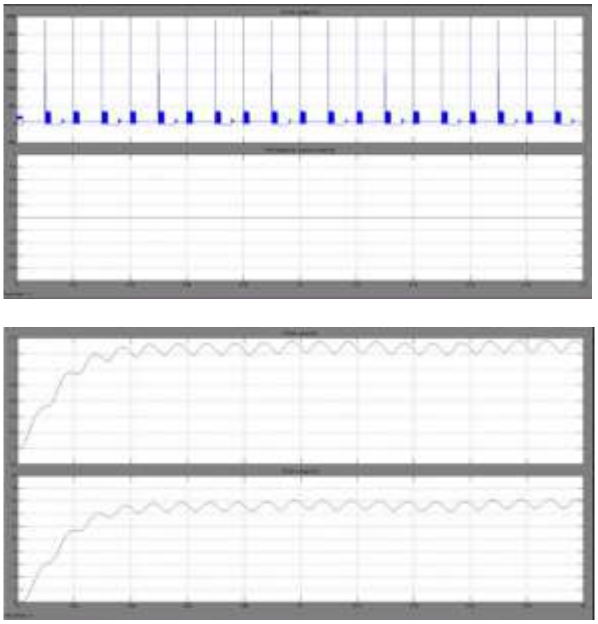


Fig 2 input and output voltages and currents

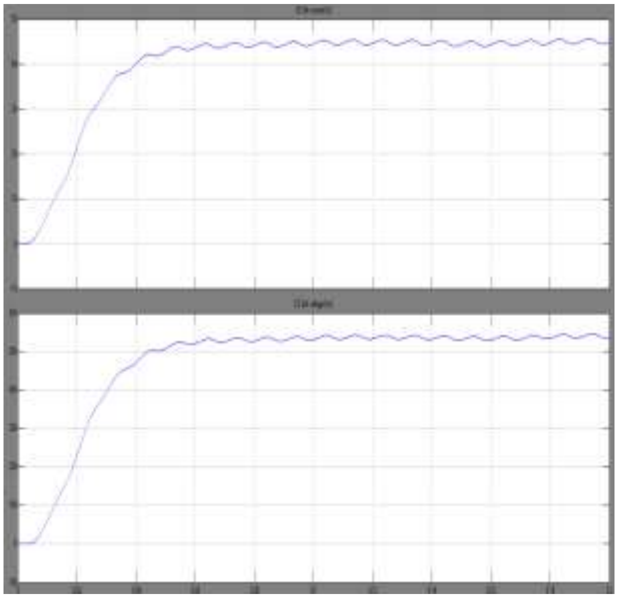


Fig 3 output voltages and currents of proposed converter

CONCLUSION

In this article, the voltage fed series compensation based ZVZCS topology and its tuning method for wireless electrical vehicle battery charger have been proposed. Suitable modifications were presented for the full-bridge dc–dc converter, and enhanced performance with a wide range of input variation is achieved. The need for a high-power processor is eliminated, which further reduces the overall cost. The theoretical analysis and modeling have been presented to obtain ZVZCS with reduced control complexity. The simulation results verified the ZVZCS condition of the proposed topology for a full load range. The offered solution produced less ripple in input/ output voltage and current while utilizing a low value of dc link, and filter capacitance values, respectively. An acceptable efficiency of 91.26% has been achieved for both battery and resistive loads.

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