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Original Article

Advanced H-Bridge Controlled Transformer-Less Buck-Boost Dc-Dc Converter for Fast Charging in Electric Vehicles

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Abstract - *The variety of electric vehicles is still restricted due to their charging periods. By introducing a new type of converter and optimization methods, the limitations of charging time can be overcome. In this work, an innovative H-Bridge controlled transformer-less Buck-Boost DC-DC Converter was proposed for EV charging applications. The main contribution of the proposed converter is to provide higher efficiency and increase the charging speed. The converter performance is verified using simulation and experimental results. Compared to other topologies, the proposed converter increases charging time and switching speed.*

Keywords - *Electric Vehicles, Dc Converter, Fast Charging.*

I. INTRODUCTION

Most of the transportation in the world is purely depends on petrol and gas. Further, a rise in fuel cost encourages people to effort on renewable solar energy and electric vehicles (EVs). In order to utilize a generated solar powerfully, a proper design of a DC-DC converter is needed.

The amassed count of EVs demands a simultaneous deployment of battery charging stations. Thus, battery charging station maintenance has a vital role in the achievement of transportation fleet electrification.

Various boost converter topologies proposed in the literature are categorized as bidirectional, minimal or non-minimal phase, soft or hard switched, unidirectional, transformer, or transformer fewer converters. These converters are used in various applications like industry, electric vehicles, and renewable energy sources. For EV charging stations, charging time is an important factor to speed up the process. But still, it is uncompleted with day-to-day altering technical approaches

In this work, an innovative H-Bridge controlled transformer-less Buck-Boost DC-DC Converter was proposed for EV charging applications. The rest of the chapter is organized as follows. Chapter 2 describes the related works on various converters. Chapter 3 explains prosed converter topology. Chapters 4 and 5 explain the implementation results and conclusion of the proposed system.

II. RELATED WORK

For an EV system, high power charging is a difficult process by its larger current and wide output voltage range. To achieve a concurrent power and current range, the careful implementation of a dc-dc converter is needed

Das, R et al. 2016 has proposed a bidirectional DC to DC converter for Electric Vehicle (EV) for driving a DC motor. Design a PI-controlled control system and high-efficiency boost converter for Electric vehicles using PWM (Pulse Width Modulation) for the generation of triggering pulse.

Hegazy et al. 2011 have proposed a novel Eight-Switch Inverter (ESI) and an interleaved DC/DC converter for electric vehicle application. The proposed converter has the ability to work as a bidirectional single-phase AC/DC battery charger/ vehicle to grid (V2G) in order to reduce the ripple of the battery current and to increase the efficiency of the DC system with a lower inductor size.

Azizi et al. 2015 have proposed a digital modulation technique for an electric vehicle. The proposed system consists of a battery, a bidirectional DC-DC converter, and a DC motor. It has only one direction of rotation but permits regenerative braking. The implementation results indicate that the speed regulator offers good efficiency on speed tracking and the elimination of disturbance load.

Kumar et al. 2016 have proposed a modified non-isolated lowest phase bidirectional DC-DC converter for EV application. It exhibits minimum phase behavior due to the complete elimination of the RHP zero. Implementation results prove the efficiency of the proposed modified non-isolated minimum phase bidirectional DC-DC converter.

Srija et al. 2019 have analyzed the performance of switched high step-up dc-dc converter topologies in electric vehicles (EV) or plug-in hybrid electric. The performance efficiency among the high gain dc-dc converters is completed using simulation and implementation results.

Young-Joo et al. 2009 have proposed an integrated bidirectional ac/dc charger and dc/dc converter for hybrid/plug-in hybrid vehicles. The proposed converter is capable of working as an ac/dc battery charger and transferring electrical energy between the battery pack and the high-voltage bus of the electric traction system.

Singh et al. 2018 have proposed a bidirectional dc-dc converter and controller design for Plug-in Electric vehicles. It requires lesser switches than conventional converters. Simulation results were used to verify the converter ability of instantaneous switching from motoring mode to regenerative braking mode.

Nick et al. 2016 have proposed a bidirectional DC-DC converter for EV. It requires only two MOSFET switches, two capacitors, two coupled inductors, and one small inductor to achieve a high gain. The MATLAB simulation results in equal good agreement to theoretical calculations.

Silvestre et al. 2008 have introduced a bidirectional DC-DC converter for a small electric vehicle. This converter is proposed to function in both directions of energy flow. Results show that higher-level control of proposed converters than other topologies.

Atmaca et al. 2019 have proposed an H-Bridge combined bidirectional DC-DC converter with an LCL filter for large energy storage applications. The proposed converter utilizes an LCL filter instead of an input inductance to reduce the battery ripple current. When compared to another converter, it uses filter inductance to achieve a reduction in copper materials.

Srivastava et al. 2018 have proposed APWM, PSM, and MDFC gating techniques for the dc-dc converter. The analysis of the converter with gating techniques was performed. The new type of full-bridge dc-dc converter with auxiliary circuit proposed to maintain the soft switching of the converter

Kejun et al. 2018 have proposed a multi-mode control strategy for DC-DC converter in EV charging applications. The control system includes three individual-specific operation modes to work in real-time load situations. It achieves efficiency above 95 %.

Hui Li et al. 2018 have proposed a small-signal model of the ZVS DHB bi-directional converter. The model precisely forecasts the effect of phase-shift control in order to achieve higher efficiency than other converters.

The converted parallel MOSFET is utilized in a conventional system. To design an efficient system, a paralleled block is exchanged by an H-Bridge control cell. In addition to the control system, two separate selection modes available to control the current path. The separate PWM control is used for separate current control.

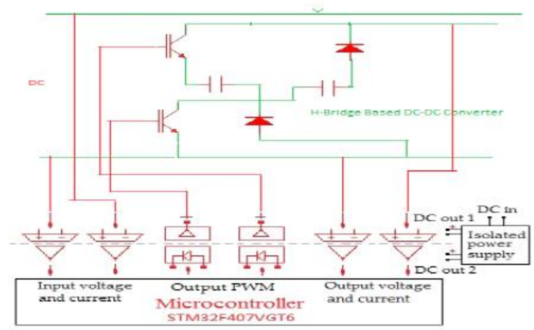

Fig. 1 Control system

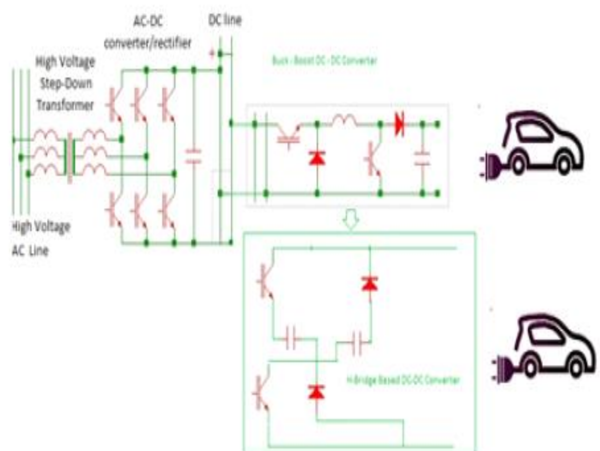

Fig. 2 Circuit Diagram

The control and circuit diagram of the proposed system is shown in the figure. A high voltage step-down transformer is linked to a buck-boost DC-DC converter. This parallel part is changed by an H-Bridge control cell and PWM signals generated by a control system. The amplitude of the signal changes by programming.

OPERATION

During the OFF time of the second semiconductor, the inductor L is charged, and the capacitor C is released. The inductor L can create the back e.m.f, and the qualities are

depending upon the pace of progress of the current of the subsequent semiconductor switch. The measure of inductance the curl can possess. Henceforth the back e.m.f can create any unique voltage through a wide reach and dictate by the plan of the circuit. Henceforth the extremity of voltage across the inductor L has switched now.
In this converter, the main semiconductor is turned ON persistently, and for the second semiconductor, the square influx of high recurrence is applied to the entryway terminal. The subsequent semiconductor is in leading when the on state and the current information stream from the inductor L during that time semiconductor. The adverse terminal was energizing the attractive field around the inductor. The D2 diode can't lead in light of the fact that the anode is on the expected ground by profoundly directing the subsequent semiconductor.

III. RESULTS AND DISCUSSION

The proposed system has been implemented using MATLAB Simulink. The input voltage for both dc voltage is set to 100V and 150V. The triggering pulse for a switch from s1 to s5 is set to 100khz.

The typical simulation results of buck-buck,buck-boost-buck-boost, and buck-buck-boost converters using MATLAB-SIMULINK, respectively. Two dc voltage sources, V1 = 100 V and V2 = 150 V, are used for the input voltage sources. The switching commands S1 and S5 have fixed duty ratios of 0.5 at a switching frequency of 100 kHz. The typical DC output value of simulated buck-buck converter is 125 V

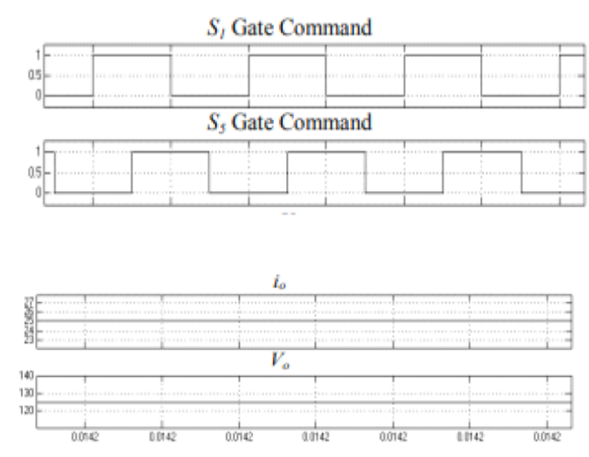

Fig. 3 Simulation results of H-bridge controlled DC-DC buck-boost converter

The above figure shows the corresponding input and output voltage waveform of the proposed converter.

CONCLUSION

In this work, we proposed an advanced H-bridge DC-DC buck-boost converter for EV charging applications. It has reduced size when compared to other topologies. The converter properties are verified using simulation and experimental results. The proposed system can also be adapted to obtain bidirectional power transfer abilities. The proposed system provides moreover existing one.

REFERENCES

[1] Hui Li, Danwei Liu, Peng, F. Z., &Gui-Jia Su. (n.d.). Small Signal Analysis of A Dual Half Bridge Isolated ZVS Bi-directional DC-DC converter for Electrical Vehicle Applications. IEEE 36th Conference on Power Electronics Specialists, (2005).
[2] Kejun, Q., Jie, S., & Yi, L..., Multi-Mode Control Based Current-Fed Full-Bridge DC-DC Converter for Electric Vehicles. International Conference on Power System Technology (POWERCON)., (2018).
[3] Srivastava, M., Tomar, P. S., &Verma, A. K., A Modified Duty Cycle Frequency Control Soft Switching of Full-Bridge DC-DC Converter for Electric Vehicle Battery Charging. 2018 8th IEEE India International Conference on Power Electronics (IICPE)., (2018).
[4] Atmaca, O., Erol, E., Kamal, T., &Karabacak, M., Design of an H-Bridge Bidirectional DC-DC Converter with LCL Filter for High Power Battery Applications. 2019 1st Global Power, Energy, and Communication Conference (GPECOM)., (2019).
[5] Silvestre, J., Half-bridge bi-directional DC-DC Converter for small Electric Vehicle. 2008 International Symposium on Power Electronics, Electrical Drives, Automation, and Motion., (2008).
[6] Nick, R., &Shahalami, S. H., Quad quadrant bidirectional DC/DC converter for electric vehicles with high gain voltage. 2016 24th Iranian Conference on Electrical Engineering (ICEE)., (2016).
[7] Singh, S. K., Kumar, D., Prakash, M., Kumar, A., & Sadhu, P. K., Analysis and Control Implementation for Instantaneous Mode Switching Bi-Directional Dc-Dc Converter for Plug-In Electric Vehicle. 2018 2nd International Conference on Power, Energy, and Environment: Towards Smart Technology (ICEPE).,(2018).
[8] Vieira, A., Mazza, L., Antunes, F., & Oliveira, D. (2018). Bidirectional dual-active-bridge DC-DC converter for vehicle-to-grid applications in DC microgrids. 2018 SimposioBrasileiro de SistemasEletricos (SBSE)., (2018).
[9] Young-Joo Lee, Khaligh, A., &Emadi, A., Advanced Integrated Bidirectional AC/DC and DC/DC Converter for Plug-In Hybrid Electric Vehicles. IEEE Transactions on Vehicular Technology, 58(8) (2009) 3970–3980.
[10] Srija, D. K., Keerthi, T. S., Anusha, R., Chandana, B. H., &Peddapati, S.. Performance analysis of non-isolated high step-up dc-dc converter topologies used in photovoltaic grid-connected electric vehicle charging stations. 2019 Fifth International Conference on Electrical Energy Systems (ICEES).,(2019).
[11] Kumar, B. V., Singh, R. K., &Mahanty, R. A modified non-isolated bidirectional DC-DC converter for EV/HEV's traction drive systems. 2016 IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES).,(2016).
[12] Azizi, I., &Radjeai, H., A bidirectional DC-DC converter fed DC motor for electric vehicle application. 2015 4th International Conference on Electrical Engineering (ICEE). doi:10.1109/intee.2015.7416683 ., (2015).
[13] Hegazy, O., Van Mierlo, J., &Lataire, P., Design and control of bidirectional DC/AC and DC/DC converters for plug-in hybrid electric vehicles. 2011 International Conference on Power Engineering, Energy and Electrical Drives., (2011).
[14] Das, R., &UddinChowdhury, M. A., PI controlled Bi-directional DC-DC converter (BDDDC) and highly efficient boost converter for electric vehicles. 2016 3rd International Conference on Electrical Engineering and Information Communication Technology (ICEEICT)., (2016).