Journal of Futuristic Sciences and Applications
Vol. 3(1), Jan-Jun 2020, pp. 1-4
doi: 10.51976/jfsa.312001
www.gla.ac.in/journals/jfsa

Bidirectional Converter for Charging/Discharging of Battery

Neeraj Kumar Pandey and Rashmi Sharma***

ABSTRACT

A better option for V2G and G2V compatibility is a bidirectional dc/dc on-board charger for EV battery discharging/charging application. Isolated converters favour working with high power densities over a wide variety of loads, which is advantageous for EV applications. For all power switches in both directions, the bidirectional converter executes the stepup and stepdown operation at zero voltage switching. There are two different types of architectures—direct and indirect architectures—that can be used to link EVs to the grid. The EV and the grid system operator only have one communication channel to use under the direct architecture. The indirect architecture, on the other hand, calls for communication between the grid operator and a middle system (sometimes referred to as an aggregator). In this essay, we focus on the earlier design. Electric vehicles (EVs) engage in continuous charge-discharge cycles when they connect to the grid to carry out various V2G services. The expense related to the EV batteries' deterioration needs to be examined and assessed, therefore these cycles may be of major concern to the owners of the vehicles. In light of this, the battery cycle life (CL) must be taken into account while talking about the battery's deterioration.

Keywords: *Islolated Converters; Operator; Bidirectional; Step Down; Step Up; Switching.*

1.0 Introduction

The globe is extremely concerned about environmental damage and global warming. The most recent assessment on global warming claims that the past 40 years have been warmer than the norm for the 20th century[1]. On record, 2016 was the warmest year ever. The earth's major temperature increase is due to greenhouse gases, such as CO2, gasoline, and gases produced during fuel combustion. The nonisolated converter's magnetic field is smaller and less.Due to the lack of a transformer, their installation is bulky, and they must also cope with dependability and low power density issues. So, it is recommended to use an isolated configuration. High efficiency is offered by the dc/dc converter with soft switching. The use of a bidirectional DC/DC converter in vehicles due to the capability of grid (V2G) and grid-to-vehicle (G2V)both directions of power flow [The flyback converter is based on a buck-boost topology, whereas the forward converter is based on a buck topology[2]. Full-bridge and half-bridge converters can also be generated from buck and boost topologies. Additionally, converter types can be categorised based on the use of transformer cores. Using a forward and flyback topology, a net DC current flows via the transformer winding, which

**Corresponding author; Assistant Professor, School of Computing, DIT University, Dehradun, Uttarakhand, India (E-mail: dr.neerajkpandey@gmail.com)*
***Assistant Professor, Ajay Kumar Garg Engineering College, Ghaziabad, Uttar Pradesh, India (E-mail: rashminonumanu@gmail.com)*

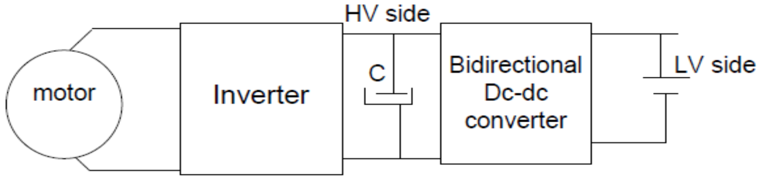
necessitates resetting the flux in the core after each switching cycle. That voltage at halfway should be equal for optimum voltage gain and energy transfer in order to achieve gentle switching in the bidirectional converter[3-4]. But,it is challenging to charge the battery during soft switching.Due to the same voltage level but a larger charging current in the middle. The battery split that is feasible for (G2V) mode of operation when a vehicle's battery splits through the use of a relay or breaker circuit in two equal voltage parts configuration.

2.0 Bidirectional Converter

The power electronic circuits consisting dc-dc or dc-ac are crucial components of an electric vehicle. A DC-AC inverter is used to power high-power electric motors, whereas DCDC converters are used to power low-power, low-voltage loads. Bidirectional high-power DC-DC converters with innovative topologies have been created for use in hybrid automobiles[5]. In this study, a non-isolated, bidirectional, half-bridge topology converter is used as the model. The nonisolated converter's magnetic field is smaller and less. Due to the lack of a transformer, their installation is bulky, and they must also cope with dependability and low power density issues. So, it is recommended to use an isolated configuration[6] .High efficiency is offered by the dc/dc converter with soft switching.The use of a bidirectional DC/DC converter in vehicles due to the capability of (V2G) and (G2V)both directions of power flow. The non-isolated bidirectional dc-dc converters used to charge and discharge the batteries have a straightforward structural design, high levels of efficiency, are reasonably priced, and are extremely reliable[8-9]

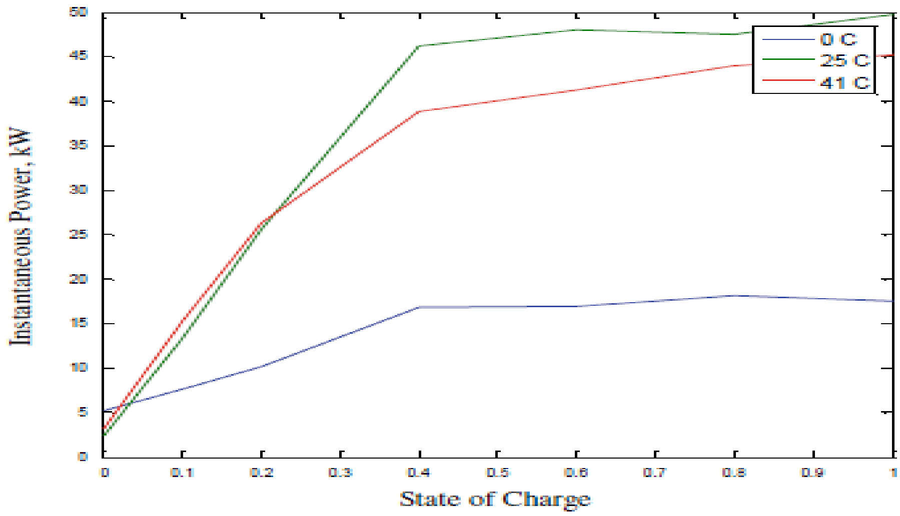
Voltage is changed by managing the converter output, which operates in buck and boost mode [9], to improve the effectiveness of battery charging and discharging.The battery is charged by the bidirectional converter, which also recovers energy during regenerative braking. The converter transfers energy to the battery as needed. To control battery charging and discharging as well as power flow, a bidirectional power converter is required.

In order to control the charging and discharging modes, a battery with a bidirectional dc-dc converter is used as energy storage in this paper. PID controllers are used to control the converter. When more power is needed, the load will be supplied by the energy storage, and during regenerative braking, the energy generated is transferred back to the battery[10]. The converter has two operating modes: boost and buck.Push-pull, full bridge, and half bridge topologies all supply the transformer with bidirectional excitation.core; the winding's net current is an AC current. As a result, the flux in the core is automatically reset at each flipping cycle's conclusion[11-12].



3.0 Results

The series-connected batteries enable proper battery discharging in step-up mode. since the difference in voltage affects the flow of current. As a result, when batteries are connected in series during step-down mode, a low charging current is detected, which results in a gradual rise in SOC. In comparison to the prior series connection, the battery separation accelerates SOC. The simulation is performed for the converter with connection in both the directions having dc-dc characteristics in up and down mode.



4.0 Conclusion

The simulation results that are done sequentially for the four different drive cycles are tested in this study using the state of charge parameter. Energy storage devices are charged when there is a low demand for electricity and discharged when there is a high demand. The factor that controls the electric range and fuel efficiency is the ESS. Currently, the two most popular ESSs for cars are batteries and ultra-capacitors. The majority of onboard electric energy is stored in batteries, which have high energy densities. The high power densities, quick charging and discharging, exceptional efficiency, and lengthy life cycles of UCs, on the other hand, are their distinguishing characteristics.

References

[1] Kebriaei, Mohammad, Abolfazl Halvaei Niasar, and Behzad Asaei. "Hybrid electric vehicles: An overview." In *2015 International Conference on Connected Vehicles and Expo (ICCVE)*, pp. 299-305. IEEE, 2015.

[2] Ruan, Jiageng, Paul David Walker, Nong Zhang, and Jinglai Wu. "An investigation of hybrid energy storage system in multi-speed electric vehicle." *Energy* 140 (2017): 291-306.

[3] Cikanek, Susan Rebecca, and Kathleen Ellen Bailey. "Regenerative braking system for a hybrid electric vehicle." In *Proceedings of the 2002 American Control Conference (IEEE Cat. No. CH37301)*, vol. 4, pp. 3129-3134. IEEE, 2002.

[4] Jeon, Soon-il, Sung-tae Jo, Yeong-il Park, and Jang-moo Lee. "Multi-mode driving control of a parallel hybrid electric vehicle using driving pattern recognition." *J. Dyn. Sys., Meas., Control* 124, no. 1 (2002): 141-149.

[5] Pisu, Pierluigi, and Giorgio Rizzoni. "A supervisory control strategy for series hybrid electric vehicles with two energy storage systems." In *2005 IEEE Vehicle Power and Propulsion Conference*, pp. 8-pp. IEEE, 2005.

[6] Piller, Sabine, Marion Perrin, and Andreas Jossen. "Methods for state-of-charge determination and their applications." *Journal of power sources* 96, no. 1 (2001): 113-120.

[7] Gao, J. P., GM G. Zhu, Elias G. Strangas, and F. C. Sun. "Equivalent fuel consumption optimal control of a series hybrid electric vehicle." *Proceedings of the Institution of Mechanical Engineers, Part D: Journal of Automobile Engineering* 223, no. 8 (2009): 1003-1018.

[8] Lukic, Srdjan M., Jian Cao, Ramesh C. Bansal, Fernando Rodriguez, and Ali Emadi. "Energy storage systems for automotive applications." *IEEE Transactions on industrial electronics* 55, no. 6 (2008): 2258-2267.

[9] Khaligh, Alireza, and Zhihao Li. "Battery, ultracapacitor, fuel cell, and hybrid energy storage systems for electric, hybrid electric, fuel cell, and plug-in hybrid electric vehicles: State of the art." *IEEE transactions on Vehicular Technology* 59, no. 6 (2010): 2806-2814.

[10] Schaltz, Erik, Alireza Khaligh, and Peter Omand Rasmussen. "Influence of battery/ultracapacitor energy-storage sizing on battery lifetime in a fuel cell hybrid electric vehicle." *IEEE Transactions on Vehicular Technology* 58, no. 8 (2009): 3882-3891.

[11] Song, Ziyou, Heath Hofmann, Jianqiu Li, Jun Hou, Xuebing Han, and Minggao Ouyang. "Energy management strategies comparison for electric vehicles with hybrid energy storage system." *Applied Energy* 134 (2014): 321-331.

[12] Geller, Benjamin M., and Thomas H. Bradley. "Analyzing drive cycles for hybrid electric vehicle simulation and optimization." *Journal of Mechanical Design* 137, no. 4 (2015).

[13] V. Goyal, P. Mishra and V. Deolia, "A Robust Fractional Order Parallel Control Structure for Flow Control using a Pneumatic Control Valve with Nonlinear and Uncertain Dynamics", Arabian Journal for Science and Engineering, vol. 44, no. 3, pp. 2597-2611, 2018.