REVIEW OF BIDIRECTIONAL DC TO DC CONVERTER WITH DUAL-BATTERY ENERGY STORAGE FOR HYBRID ELECTRIC VEHICLE SYSTEM

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Abstract: - The Bidirectional DC-DC Converter block represents a converter that steps up or steps down DC voltage from either side of the converter to the other as driven by an attached controller and gate-signal generator. A bidirectional chopper (BDC) is the one which can interface main source (HVS), auxiliary source (LVS) and a DC-Bus voltage at different levels which is implemented in Hybrid Electric Vehicle (HEV). This converter operation is of two modes namely dual source powering mode and energy re generation mode along with power flow control in both the directions. And also the independent power flow control across two sources (i.e. the dual source buck-boost mode).

Index Terms: - BDC, DUAL BATTERY

STORAGE, HYBRID ELECTRIC VEHICLE.
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I. INTRODUCTION

In electric engineering, a DC to DC converter is a category of power converters and it is an electric circuit which converts a source of direct current (DC) from one voltage level to another, by storing the input energy temporarily and then releasing that energy to the output at a different voltage**.** A concern has been developed all over the world because of rise in global warming as well as rise in pollution. There is a need to look for alternatives because of various reasons like increasing rates of fuel, increased dependency over conventional fuel and change in driving trends. By using voltage source inverter, both electric vehicle and hybrid electric vehicles get charged from the battery. It's really useful to keep the battery voltage rating pretty low for vehicle performance improvement, as this implies using fewer series-connected cells. Although from the perspective of the engine, since the voltage rating and the power upplied by the engine are completely dependent, it is important to have a high-voltage DC bus. In addition,in the case of permanent magnet synchronous machines, moving the flux-weakening region to the high- speed region is particularly convenient for a high-voltage DC bus. A controlled DC voltage is an additional advantageous feature of the implementation of a DC/DC converter, which results in greater motor drive output. As a result, in order to balance the various voltage ratings of these two components, a DC/DC bidirectional converter is normally inserted between both the battery as well as the inverter. [3] There is a need to look for alternatives because of various reasons like increasing rates of fuel, increased dependency over conventional fuel and change in driving trends. Normal climate meetings have been held everywhere in the world, along with the most prominent, i.e. The Kyoto Protocol discusses major concerns related to environmental impacts due to global warming and industrial and automobile pollution. There are various regulations to be imposed by governments to reduce the impact of reducing the emission of toxic gases like carbon dioxide and other lead replacements due to the combustion of fuel for automotive applications. In this study, the recent and future possible trends are also discussed about Hybrid Electric Vehicle Industry. [1] Depletion of conventional resources, rise in price of oil and rise in carbon emission are the major concern in the present world. These concerns are especially faced in developing nations like India because of growing cities, rapid economic developments and increasing traffic. Among all these reasons of concern, power grids and ICE vehicles are the major source of carbon emission. All such concerns increase the motivation for using Electric vehicles in transportation. This change will help in making our planet greener and cleaner environment. [2]

2. LITERATURE REVIEW

Recently, Hybrid Electric Vehicles (HEV) has seen enormous development around the world **(Sonar, 2020).**
HEV's growth in this field has been huge. Because of rising emissions from traditional cars, rising fuel costs, and global warming environmental issues, the automotive sector is turning its attention towards developing HEVs. The HEVs have various configurations depending on the hybridization degree to provide simultaneous traction efficiency for the IC engines and electric batteries. There are a physical description and simulation of hybrid fuel vehicles. In this article, the bidirectional complete bridge dc-dc converter, and the implementation of this converter in Series- Parallel HEV is discussed. The topology of the transforming converter accounts for motoring as well as regenerating breaking operations. The value of the dc-dc converter is suggested. **(Sowmya et al., 2017)** [2] It was proposed to promote recovery of energy before and during braking downhill travel by using a bi-face DC- DC converter between the power source and traction engine. This integration will also increase traction driving performance and improve the range by 25 percent. Now the right bidirectional DC-DC converter heading can be used to maximize architecture efficiency in order to decrease weight, size, and system expense. This paper reviews

and explores the fundamental bidirectional topology of the DC- DC converter and describes the comparative benefits for making the right electric car design decision.

(Chakraborty et al., 2019) [4]This paper discusses the scientific implications, the state of the world of research and development. In the sense of increasing alarm over increased emissions and the resulting global warming, Hybrid Electric Vehicles (HEV) has earned considerable interest. HEV is driven by a battery or mixed with electricity. HEV is primarily driven by a bacterium. HEV and other vehicle configurations such as Battery Electric Vehicles (BEV), Plug-in Hybrid Electric Vehicles (PHEV) is also gaining importance with growing concern towards the environment.

(SaiTeja et al., 2019) [5] Highlighted that "a bidirectional chopper (BDC) is the only element which can interface main source (HVS), auxiliary source (LVS), and a DC Bus voltage at different levels which is implemented in Hybrid Electric Vehicle (HEV)". This transformer process is composed of different mechanisms: double operation and refurbishing function in both dimensions with voltage regulation. And the autonomous supply voltage regulates two outlets (i.e., the dual-source buck- boost mode). Simulated results have included the regulation of the loop and the contrast between PI and ANN regulation, as well as the closed neural artificial network (ANN).

(De Melo et al., 2020) [6] Submitted that electric hybrid cars and pure electric vehicles, where successful conservation of energy is critical, rely on energy storage systems (ESDs) and electronic transformers. In this paper, a proposed EV architecture is explored based on super condensers (SCs) and packs for a safe and rapid electrical transition. The transfer of power according to the above sources of energy to the EV occurs through the DC-converter link. The topology reveals the small number and high reliability of modules over a wide spectrum of loads suitable for high-performance, high- current values. The systematic modeling method includes the evaluation of the transformer and operation of the control system by a fundamental approach, namely the average current mode function.

(Devi Vidhya&Balaji, 2020) [7]The electronic power interface, with its powerful control system, has an important role in the use of energy sources to use electric cars. For this reason, a multiple-input converter (MIC) topology hybrid fuzzy pi-based control scheme is suggested. Include a traditional solid PI controller and fluid transfer PI in the proposed hybrid fuzzy PI controller. The proposed control design also supports the monitoring of a pre-defined speed profile to complete electric vehicle development. Detailed simulation and efficiency analyses are carried out with traditional controllers. The results show that the device is resilient and offers two-way power control, fast monitoring capability with less stable state error, increased dynamic response by improving flexibility and proper use of energy sources. A simulation of the output of the multi-input converter in the MATLAB/SIMULINK environment with the built control system is performed.

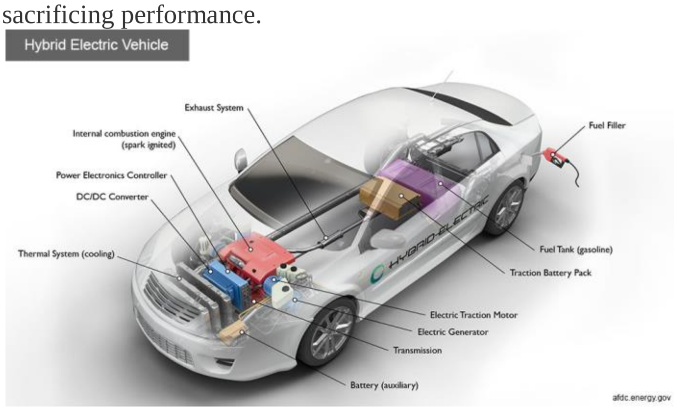
(Antony &Rajitha, 2020) [8] Announced that a range of applications such as electric vegetables, renewable sources, and UPS have been transformed by DC-DC converters. These converters are useful to transform the direct current to various voltage levels. A two-way DC-DC converter (BDC) is a DC-DC converter which, with its high power transmission and reduced dimensions, is used to flow power in both directions and dominates unidirectional converters. Therefore the industrial and testing areas of these transformers obtain more attraction. In two key modes, these converters operate. Buck or low-stress mode, while the other is high tension or boost mode. The output voltage in buck mode is lower than the input, and in boost mode, the output is higher than the specified input. These papers propose a two- way DC-DC converter that functions in buck and boost modes and is being tested in its use in battery-powered vehicles. The added value of this converter is the ability to charge the grid.

(Jagadeesh&Indragandhi, 2019) [9] Paper with a variety of DC-DC converters such as sepic, boost or bidirectional converter is reported. Integrating the booster, the sepic, two-way DC-DC converter helps you to define the required converter with an exact power rating for renewable energy applications. On the basis of this analysis, the efficiency of the non- isolated converter is evaluated. So the converter is used to move up/down the voltage stage, so the conversion efficacy of PV is low. This paper aims to carry out an analysis of the performance and voltage and current tension on the converters of the DC-DC converters. The simple electric photovoltaic vehicles and electric fuel cells are discussed in depth.

3. METHODOLOGY

3.1 How does hybrid electric vehicle work?

Hybrid electric vehicles are powered by an internal combustion engine and an electric motor, which uses energy stored in batteries. A hybrid electric vehicle cannot be plugged in to charge the battery. Instead, the battery is charged through regenerative braking and by the internal combustion engine. The extra power provided by the electric motor can potentially allow for a smaller engine. The battery can also power auxiliary these features result in better fuel economy without sacrificing performance.



3.2Bidirectional DC to DC converter

The Bidirectional DC/DC converter feature consists of interfacing with the DB bus of the driving inverter with dual-battery energy storage.

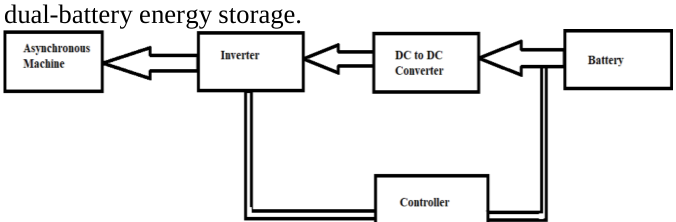


Figure 1 Block Diagram of DC to DC Convertor

4. KEY COMPONENTS OF A HYBRID ELECTRIC CAR

Battery (auxiliary): In an electric drive vehicle, the low-voltage auxiliary battery provides electricity to start the car before the traction battery is engaged; it also powers vehicle accessories.
DC/DC converter: This device converts higher-voltage DC power from the traction battery pack to the lower-voltage DC power needed to run vehicle accessories and recharge the auxiliary battery.
Electric generator: Generates electricity from the rotating wheels while braking, transferring that energy back to the traction battery pack. Some vehicles use motor generators that perform both the drive and regeneration functions.
Electric traction motor: Using power from the traction battery pack, this motor drives the vehicle's wheels. Some vehicles use motor generators that perform both the drive and regeneration functions.
Exhaust system: The exhaust system channels the exhaust gases from the engine out through the tailpipe. A three-way catalyst is designed to reduce engine-out emissions within the exhaust system.
Fuel filler: A nozzle from a fuel dispenser attaches to the receptacle on the vehicle to fill the tank.
Fuel tank (gasoline): This tank stores gasoline on board the vehicle until it's needed by the engine.
Internal combustion engine (spark-ignited): In this configuration, fuel is injected into either the intake manifold or the combustion chamber, where it is combined with air, and the air/fuel mixture is ignited by the spark from a spark plug.
Power electronics controller: This unit manages the flow of electrical energy delivered by the traction battery, controlling the speed of the electric traction motor and the torque it produces.
Thermal system (cooling): This system maintains a proper operating temperature range of the engine, electric motor, power electronics, and other components.
Traction battery pack: Stores electricity for use by the electric traction motor.
Transmission: The transmission transfers mechanical power from the engine and/or electric traction motor to drive the wheels.

5. MODES OF OPERATION

A present bidirectional dc to dc converter with dual-battery voltage sources is given in Fig. 2. where $VBUS$, $VHVE$, and $VLVE$ represent the DC-Bus voltage, main source (HVS) and auxiliary source (LVS) respectively. The power switch $SHVS$ used to switch on and the $SLVS$ is used to switch off the converters current loops of $VHVE$ and $VLVE$, respectively. A pump capacitor (CP) is introduced as voltage divider for four active switches ($S1$,$S2$,$S3$,$S4$) and two inductors (LA, LB) to increases the voltage gain between low-voltage sources $VHVE$, and $VLVE$. CP decreases the voltage stress across the switches and eliminates the need of extreme duty. The four-quadrant operation of circuit is possible by the bidirectional switches (S, $SHVS$,$SLVS$), and allows the power flow control between two low voltage sources $VHVE$, and $VLVE$, and also helps in blocking positive and negative voltages. The bidirectional switches (S, $SHVS$,$SLVS$) are MOSFETS connected back to back as a. *Dual-Source low voltage powering mode*

In this mode of operation the switch S is turned off and the switches $SHVS$,$SLVS$ are turns on and the two voltage sources supplies the energy to the DC-Bus, the schematic circuit shown in Fig

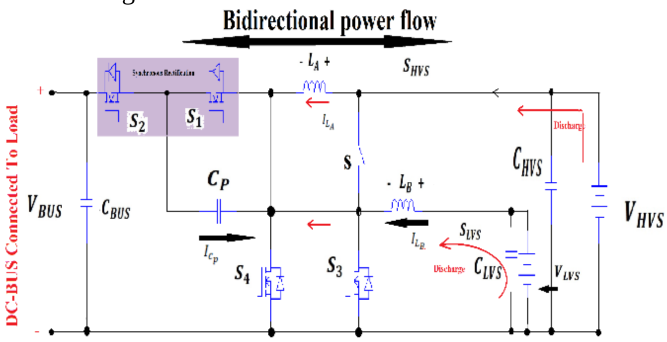


Fig. Dual-Source Low Voltage Powering Mode

6. CONCLUSION

This paper presents A bidirectional DC to DC converter(BDC) is presented interface main source (HVS), auxiliary source (LVS) and a DC-Bus with different voltage levels which is implemented in Hybrid Electric Vehicle (HEV). The circuit operating principle and modes of operation of bidirectional dc to dc converter were discussed and Simulation waveforms of Dual Source Low Voltage Powering Mode, DC Bus High Voltage Regenerating Mode, Dual-Source High Voltage Boost/Buck Mode and the comparison between PI and ANN are demonstrated that it can be successfully implemented for the hybrid electric vehicle.

REFERENCES

1.Andrea Aurora Racz, Ionut Muntean and Scrgiu-Dan Stan , "A look in to hybrid/electric cars from an ecological prospective" , *Science Direct 8TH international conference INTER-ENG 2014*.
2. G. Gruosso, "Optimization and management of energy power Flow in Hybrid Electrical Vehicles", *5th IEEE transactions Hybrid and Electric Vehicles Conference (HEVC 2014).*
3. Antonio Sciarretta And Lino Guzzella "Control of Hybrid Electric Vehicles" *IEEE control systems magazine 2007.*
4. Bussa Vinod Kumar, R. K. Singh and R. Mahanty "A Modified Non- Isolated Bidirectional DC-DC Converter for EV/HEV's traction drive systems" *IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES) 2016.*
5. Ching-Ming Lai, Member, Yu-Huei Cheng, Ming-Hua Hsieh, and Yuan-Chih Lin, "Development of a Bidirectional DC/DC Converter with Dual-Battery Energy Storage for Hybrid Electric Vehicle System " *IEEE Transactions on Vehicular Technology 2017.*
6. Ching-Ming Lai, Yuan-Chih Lin and Dasheng Lee "Study and Implementation of a Two-Phase Interleaved Bidirectional DC/DC Converter for Vehicle and DC-Microgrid Systems" *MDPI journals Energies 2015.*

7. Ching-Ming Lai, “ Development of a Novel Bidirectional DC/DC Converter Topology with High Voltage Conversion Ratio for Electric Vehicles and DC-Microgrids” *MDPI journals Energies may 2016.*

8. Biao Zhao, Qiang Song, and Wenhua Liu “Power Characterization of Isolated Bidirectional Dual-Active-Bridge DC–DC Converter With Dual-Phase-Shift Control” *IEEE transactions on power electronics, vol. 27, no. 9, september 2012.*

9. Lei Jiang, Chunting Chris Mi, Siqi Li, Mengyang Zhang, Xi Zhang, and Chengliang Yin “A Novel Soft-Switching Bidirectional DC–DC Converter With Coupled Inductors” *IEEE Transactions on industry applications, vol. 49, no. 6, november/december 2013.*

10. Mohd. Arif Khan, “ANN Based Simulation of PWM Scheme for Seven Phase Voltage Source Inverter using MATLAB/Simulink”, *Research gate journals 18th International Conference on Wireless Communication 2016.*

11. C. Subramani, A. A. Jimoh, Harish Kiran S, Subhransu Sekhar Dash, “Artificial Neural Network based Voltage Stability Analysis in Power System”. *International Conference on Circuit, Power and Computing Technologies 2016.*

12. Sayidul Morsalin, Khizir Mahmud and Graham Town “Electric Vehicle Charge Scheduling Using An Artificial Neural Network*” IEEE Conference Innovative Smart Grid Technologies – Asia 2016.*

13. Ala A. Hussein, “A Neural Network Based Method for Instantaneous Power Estimation in Electric Vehicles’ Li-ion Batteries” *IEEE Applied Power Electronics Conference and Exposition 2017.*

