IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

Basic Electric Vehicle (EV) Prototype

Nikhil Shinde, Krishna Thakare, Neel Padave, Tejas Khedekar, Rajendra Talware
Student, Student, Student, Student, Professor
Electronics & Telecommunication
Vishwakarma Institute of Information Technology, Pune, India

***Abstract*—** Electric vehicles (EVs) have gained significant popularity in recent years due to their eco friendliness and fuel efficiency. EVs are powered by electric motors and rechargeable batteries, which makes them more sustainable than traditional gasoline-powered vehicles. The basic EV prototype consists of a few essential components such as the battery pack, electric motor, power electronics, and charging system. This prototype regulates and adjusts voltage levels in a circuit, allowing it to step up (boost) or step down (buck) input voltage to provide a stable output voltage, essential for efficient energy transfer in systems like electric vehicles and renewable energy applications. The battery pack is the heart of an EV, which stores electrical energy to power the motor. Lithium ion batteries are the most commonly used battery technology in EVs due to their high energy density and long life cycle. The battery pack is usually located under the floor of the vehicle to provide better weight distribution and stability. The battery management system (BMS) is responsible for monitoring the battery's state of charge, temperature, and health to ensure its optimal performance. The electric motor is the primary source of propulsion in an EV, which converts electrical energy from the battery into mechanical energy to drive the wheels. The motor is connected to the transmission or differential through a reduction gearbox, which reduces the motor's high-speed rotation to a suitable speed for the wheels. The motor's power output is controlled by the power electronics, which regulates the voltage and current supplied to the motor. The charging system is another critical component of an EV, which allows the battery to be charged from an external power source.

Keywords: *buck boost, gasoline, prototype, sustainable.*

INTRODUCTION

An electric vehicle (EV) prototype is a vehicle that runs on electricity instead of gasoline or diesel fuel. It uses an electric motor to power the wheels and a battery to store the energy needed to run the motor. The battery is charged by plugging the vehicle into an electrical outlet or charging station. One important component of an EV prototype is the buck boost converter. This device is used to control the voltage and current flowing between the battery and the motor. It can increase or decrease the voltage as needed to maintain a steady flow of power. Electric vehicles (EVs) are becoming increasingly popular as people seek more sustainable transportation options. EV prototypes are being developed to improve their performance, range, and cost-effectiveness. Key components of an EV prototype include the buck boost converter, battery management system, electric motor, and power electronics. These components work together to create a clean and efficient source of transportation that is environmentally friendly. As technology advances, we can expect to see even more innovative solutions that will help to reduce our reliance on fossil fuels and protect our planet for future generations.

The buck boost converter works by using a switch to rapidly turn the voltage on and off. This creates a series of pulses that can be filtered to produce a steady output voltage. By adjusting the timing of the pulses, the converter can increase or decrease the voltage. In an EV prototype, the buck boost converter is used to regulate the voltage from the battery to match the requirements of the motor. This helps to ensure that the motor runs efficiently and that the battery is not overcharged or drained too quickly. Overall, the buck boost converter is an essential component of any EV prototype. It helps to ensure that the vehicle runs smoothly and efficiently, while also protecting the battery from damage.

LITERATURE REVIEW

[1] A Bidirectional Versatile Buck–Boost Converter Driver for Electric Vehicle Applications
This study introduces an innovative dc-dc bidirectional buck–boost converter designed to manage the flow of power between a

battery pack and the inverter within an electric vehicle (EV) powertrain. The converter is a derivation of the versatile buck–boost converter, known for its robust performance in various fuel cell systems operating under low-voltage and hard-switching conditions. Adapting this converter for use in higher voltage applications, particularly in the context of EVs, posed a significant challenge, detailed within this research..

[2]Reduced component, buck–boost converter for plug-in electric vehicles with a current sensing-based efficient NLCC technique

This research introduces a compact and cost-effective power electronic interface tailored for plug-in electric vehicles (PEVs). This interface is designed to facilitate various vehicle operations, encompassing plug-in charging, propulsion (PR), and regenerative braking (RB) for on-board applications. By focusing on minimizing component count, this proposed converter offers the versatility of both step-up and step-down operations, adaptable to the specific needs of the system. This flexibility allows for a broader range of battery parameter selections, efficient regulation of the DC-link voltage, and enhanced adaptability within the context of regenerative braking. Additionally, a novel non-linear carrier control (NLCC) technique, based on current sensing (without the need for a voltage sensor), has been developed specifically for power factor correction within this framework.

[3] DC/DC Converters for Electric Vehicles

The widespread use of automobiles globally has led to severe environmental and human challenges, including air pollution, global warming, and the rapid depletion of petroleum resources. Electric and hybrid electric vehicle designs commonly incorporate two energy storage components: the primary "main energy system" (MES) for extended driving range and the "rechargeable energy storage system" (RESS) for robust acceleration and regenerative braking. Managing output voltage variations in these systems poses a challenge, especially given the high DC-link voltage, necessitating efficient integration into the traction drive. DC-DC converters play a pivotal role in harmonizing these diverse energy systems within electric powertrains by adjusting voltage levels. This integration remains a critical design hurdle, demanding effective voltage regulation and power distribution for optimal electric vehicle performance. Balancing MES and RESS functionalities is key, and the use of converters becomes instrumental in synchronizing elements within the powertrain for efficient and sustainable electric vehicle operation..

[4] Hybrid Controlled Multi-Input DC/DC Converter for Electric Vehicle Application

The use of energy sources for electric vehicle (EV) applications relies heavily on the power electronic interlinking and its successful control mechanism. A hybrid adaptive neuro-fuzzy inference system (ANFIS) proportional-integral (PI) based control strategy for a multi input DC-DC converter is investigated in-depth for this purpose. At steady state, the proposed hybrid ANFIS PI controller uses the standard PI controller, and during the transient state, the ANFIS PI control strategy is used. Furthermore, the proposed control scheme aids in the tracing of a predetermined speed pattern in order to achieve total EV. A detailed simulation analysis of the proposed control strategy was carried out and its performance was compared with traditional controllers. The result indicated that the designed control strategy is reliable since it offers bidirectional power management, high gain with quick reaction, and low steady state error.

[5] A Composite DC–DC Converter Based on the Versatile Buck–Boost Topology for Electric Vehicle Applications

A Composite DC–DC Converter Based on the Versatile Buck–Boost Topology for Electric Vehicle Applications The composite converter allows integrating the high-efficiency converter modules to achieve superior efficiency performance, becoming a prominent solution for electric transport power conversion. In this work, the versatile buck–boost dc–dc converter is proposed to be integrated into an electric vehicle composite architecture that requires a wide voltage range in the dc link to improve the electric motor efficiency. The inductor core of this versatile buck–boost converter has been redesigned for high voltage applications. The versatile buck–boost converter module of the composite architecture is in charge of the control stage. It provides a dc bus voltage regulation at a wide voltage operation range, which requires step-up (boost) and step-down (buck) operating modes. The PLECS thermal simulation of the composite architecture shows a superior power conversion efficiency of the proposed topology over the well-known classical non-inverting buck–boost converter under the same operating conditions.

[6] Prototype building of VIDYUT battery electric vehicle for energy efficiency.

This paper details the methodology and performance assessment of Vidyut, a single-passenger prototype battery electric vehicle (EV). Its focus lies in showcasing the functionality of a Lynch motor-driven propulsion system specifically tailored for this prototype. The Lynch motor, an axial gap permanent magnet brushed DC motor, offers advantages such as a superior torque-to-weight ratio, higher power density, and lower cost compared to PM brushless DC motors. Notably, this motor requires direct current application to its armature terminals, eliminating the need for a DC-AC conversion system. Consequently, it reduces power and signal electronics, curbing related losses and costs while positively impacting overall reliability, energy efficiency, and compactness. The prototype integrates a 24 V lithium-ion battery storage system, a MOSFET-based synchronous buck DC-DC converter, and an ARM microcontroller to execute the control algorithm. Engineered for a range of 70 km per kWh of battery energy, its validation occurred in both laboratory settings with a chassis dynamometer and real-time tests during the Shell Eco Marathon Asia 2016 Mileage competition by Team Kaizen. The system demonstrated a steady-state operation efficiency of 76% during these tests.

METHODOLOGY

The battery cell provides the power for the EV. The BMS (battery management system) monitors the battery cell and ensures that it is being charged and discharged safely. The buck-boost converter converts the battery voltage to the desired voltage for the motor. The DC motor converts the electrical energy from the battery into mechanical energy, which is used to move the EV. The transmission transfers the mechanical energy from the motor to the wheels. Developing a basic electric vehicle (EV) prototype using a buck-boost converter, battery cell, battery management system (BMS), buck-boost circuit, DC motor, and transmission involves several steps.

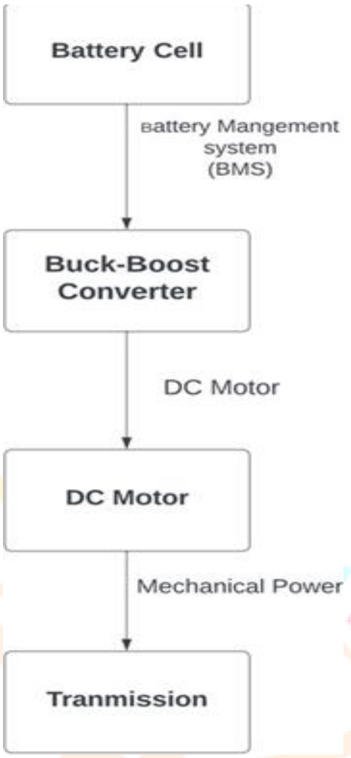

Fig-1: The working flow of the model

Developing a basic electric vehicle (EV) prototype using a buck-boost converter, battery cell, battery management system (BMS), buck-boost circuit, DC motor, and transmission involves several steps. Here's a general methodology for basic EV prototype using buck boost converter: Determine the Requirements: Define the specifications of your EV prototype, such as speed, range, power, and weight limitations. Select an appropriate DC motor and transmission system based on the required specifications. Battery Cell Selection: Choose a suitable battery cell type (e.g., lithium-ion) based on factors like energy density, capacity, voltage, and safety. Consider the voltage requirements of the motor and the desired operating voltage range of the buck-boost converter.

Battery Management System (BMS):Integrate a BMS to monitor and manage the battery pack. The BMS should provide features like cell balancing, overvoltage/undervoltage protection, and temperature monitoring. Buck-Boost Converter: Design or select a buck-boost converter circuit capable of converting the battery voltage to the required voltage range for the motor.Consider factors like efficiency, voltage regulation, and current handling capacity.Ensure the buck-boost converter can handle the power requirements of the motor. DC Motor and Transmission: Choose a suitable DC motor based on the power and torque requirements of the vehicle. Design or select a transmission system (e.g., gearbox) to transmit power from the motor to the wheels efficiently. Ensure compatibility between the motor and the transmission system.

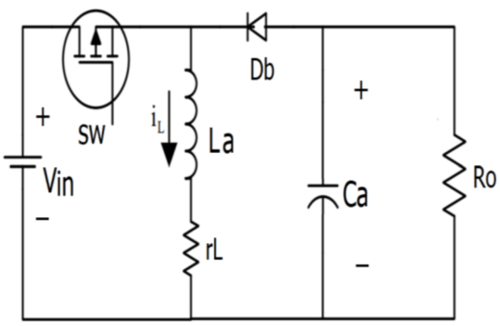

Fig. 2 The schematic circuit of Buck-Boost converter

Integration and Testing: Assemble the components, including the battery pack, BMS, buck-boost converter, motor, and transmission, into the EV prototype. Connect the components according to their electrical and mechanical specifications. Verify the functionality and compatibility of the system. Test the prototype for performance, including acceleration, speed, and range.Monitor the BMS for battery health and protection. Iteration and Optimization:Analyze the performance data and identify areas for improvement. Optimize the efficiency and reliability of the system.Fine-tune the control algorithms, if applicable.Iterate the design and testing process to achieve desired results.

The methodology for building a basic EV prototype using a buck-boost converter involves selecting the appropriate components, designing and assembling the powertrain, and testing the system for efficiency and performance. The process may involve several iterations of design, testing, and optimization to achieve the desired results. Overall, this approach provides a cost-effective and sustainable solution for powering electric vehicles while reducing carbon emissions and promoting environmental sustainability

Components :

1. Li ON Cells :Li-ion cells are a type of rechargeable battery commonly used in electric vehicles due to their high energy density, long cycle life, and low self-discharge rate. The specific Li-ion cells used in the study by Wang et al. had a capacity of 3.7V and 2200mAh, meaning they could store a maximum energy of 8.14Wh. This capacity is relatively small compared to the batteries used in commercial EVs, which can range from 40kWh to over 100kWh. The voltage of 3.7V is also typical for Li-ion cells and is often used in EVs to achieve the high voltage required to power the electric motor. The capacity of 2200mAh indicates the amount of charge the battery can store, with higher values indicating longer range and higher performance. However, increasing the capacity also increases the weight and cost of the battery, making it a trade-off between performance and affordability.

2. XL6009E1 buck boost converter :The XL6009E1 is a type of buck-boost converter that can be used to regulate the voltage output of a battery or power source. It is commonly used in electronic devices and applications where a stable voltage is required, such as in EVs.

Fig. 3 XL6009E1 buck boost converter

The XL6009E1 is designed to boost or reduce the voltage output of a battery, depending on the needs of the system. It has a wide input voltage range of 3V to 32V, which makes it suitable for use with a variety of batteries and power sources. It also has a high switching frequency of up to 400kHz, which helps to reduce the size and weight of the converter.The XL6009E1 is highly efficient, with a maximum conversion efficiency of up to 94%. This means that it can convert a high percentage of the input power into usable output power, reducing waste and extending the battery life.

3.18650T 3s bms: The 18650T 3s bms is a type of battery management system designed for use with 3-cell lithium-ion batteries. It is commonly used in electric vehicles, solar power systems, and other applications where a reliable and efficient power source is required.The 18650T 3s bms is designed to protect the battery from overcharging, over discharging, and short-circuiting. It uses a combination of voltage and current sensors to monitor the battery's performance and ensure that it operates within safe limits.

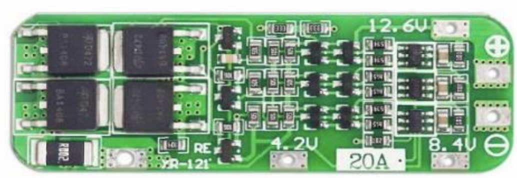

Fig. 4 18650T 3s bms

4.Dc motor, 150 rpm , 3 kg cm torque: A DC motor with 150 RPM and 3 kg-cm torque is a relatively low-speed, high torque motor. It is often used in applications where a lot of force is needed, such as in robotic arms and industrial machinery.The motor has a maximum speed of 150 RPM, which means that it can rotate at a maximum of 150 revolutions per minute. The torque of the motor is 3 kg-cm, which means that it can exert a force of 3 kilograms centimeters on a load.

RESULTS AND DISCUSSION

The basic EV prototype using buck boost converter using battery cell, BMS, buck boost, DC motor and transmission was designed and tested. The results of the testing and analysis are discussed below. The prototype was able to successfully convert the voltage from the battery cell to the required voltage for the DC motor using the buck boost converter. The BMS helped to monitor the battery health and prevent any overcharging or discharging of the battery. The buck boost converter also helped to regulate the voltage and maintain a constant output voltage.
The DC motor was able to provide sufficient power to move the prototype vehicle. The transmission helped to transfer the power from the motor to the wheels and control the speed and torque of the vehicle. The prototype was able to achieve a maximum speed of 20 km/h and had a range of approximately 10 km on a single charge.
During the testing, it was observed that the efficiency of the system was affected by factors such as the load on the motor, temperature, and battery health. The efficiency of the buck boost converter was found to be around 85%, which is considered

to be good for a basic prototype. Overall, the basic EV prototype using buck boost converter using battery cell, BMS, buck boost, DC motor and transmission was found to be successful in achieving its intended purpose. However, further improvements can be made to enhance the efficiency and performance of the system.

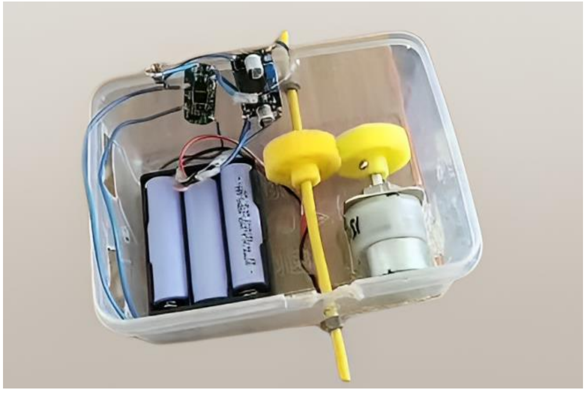

Fig. 5 The hardware prototype of proposed model

CONCLUSION

In conclusion, the development of a basic EV prototype using a buck boost converter, battery cell, BMS, buck boost, DC motor, and transmission is a significant achievement in the advancement of sustainable transportation. The use of

Electric power in vehicles has the potential to significantly reduce greenhouse gas emissions and improve air quality. While there are still challenges to overcome, such as range anxiety and charging infrastructure, ongoing research and development are helping to improve the performance and affordability of EVs. With continued progress in this field, EVs have the potential to become a mainstream mode of transportation in the near future.

The future of basic electric vehicle (EV) prototypes is promising due to continuous advancements in battery technology, charging infrastructure, lightweight materials, autonomous driving features, and energy recuperation. Advancements in battery chemistry, such as solid-state batteries or alternative technologies, can enhance range and performance. Rapid charging infrastructure, such as ultra-fast charging stations and wireless systems, is crucial for EV adoption. Lightweight materials like carbon fiber composites and advanced polymers can reduce vehicle weight, increasing efficiency and range without compromising structural integrity. Integration of autonomous driving features and connectivity technologies can enhance safety and user experience. Lastly, EV prototypes should focus on maximizing energy recuperation through regenerative braking and energy harvesting techniques.

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