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REVIEW ON HIGH VOLTAGE GAIN FOR EV APPLICATIONS WITH SOFT SWITCHING MULTIPHASE INTERLEAVED BOOST CONVERTER

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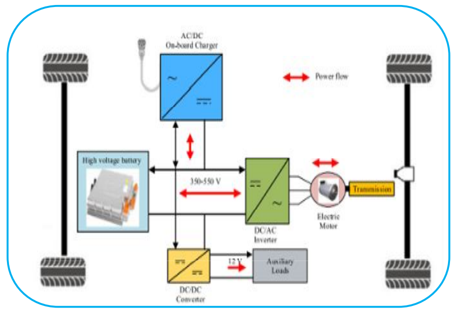
ABSTRACT :

The automotive industry is beginning to recognize fuel-cell electric cars, or FCEVs, as a way to meet increasingly strict fuel efficiency and carbon emission rules. The 1.26 kW Proton Exchange, also referred Microfiber Fuel Cell (PEMFC) that powers an electric vehicle engine via a high voltage-gain DC to DC boost converter is the main topic of the introduction. In the study, it is suggested that the PEMFC be equipped with a MPPT (Maximum Power Point Tracking), regulator that is based on neural networks. The recommended MPPT controller tracks the PEMFC's Maximum Power Point (MPP) using the Radial Base Function Network (RBFN) algorithms. For optimal operation, FCEVs require high frequency as well as voltage gain DC as DC converters. In order to get better voltage gain, the research also investigates the creation of a customized three-phase high-voltage Interleaved Boosting Converter (IBC) for the Fuel Cell Electrical Vehicle (FCEV) system. In order to lessen voltage stress upon semiconductor circuits and minimize input current ripple, The interleaving technique is used. This study evaluates and contrasts the Fuel Cell electrical vehicle (FCEV) system's performance using a fuzzy logic controller and a traditional Radial Base Function Networks (RBFN)-based Maximum Power Point Tracking (MPPT) control unit. The MATLAB/Simulink environment is used to carry out the evaluation.



KEY WORDS: *Fuel cell electric vehicle, high voltage gain IBC, PEMFC, MPPT, RBFN etc.*

I. INTRODUCTION:

The automotive industry is moving towards electric vehicles due to worries about environmental degradation and the depletion of fossil fuel resources, particularly Fuel Cell Electric Cars (FCEV). Significant advances in power gadgets electric cells technology, and mobile devices have all aided the development of fuel cell vehicles. Fuel cells provide advantages such as increased energy generation, increased dependability, greater performance, and reduced noise levels.

There are many kinds of fuel cells that are used to classify mobile ions according to how acidic they are. These include fuel cells that use molten carbon, Proton Exchange Membranes Fuel Cells (PEMFC), Alkalinity Fuel Cells (AFC), Phosphorous Acid Fuel Batteries (PAFC), and Solid Oxide Fuel Cells (SOFC). PEMFCs stand apart from the auto industry because of their rapid start-up and capacity to work in a wide range.

FUEL CELLS -

- After then, owing to the environment, deterioration and even, ultimately, Natural Depots, the automobile sector displays an increased enthusiasm in electric vehicles.
- The fuel cell offers pollution-free energy generation, great dependability, efficiency, and low noise levels.
- PEMFCs are not in demand in the automobile sector due to its minimal startup costs and low operating temperature.

MPPT -

- Uses MPPT P&O algorithms in a simple and user-friendly style and the endeavor's administration methodology provides variations in the steady state, which can lead to reduced efficiency in mobile systems.
- The challenge is solved using Logic controllers and neural network methods to assess the accuracy and effectiveness of MPPT.
- The proposed PEMFC MPPT Track is based on the RBFN MPPT control base.
- The high-voltage, non-isolated intermittent step-up converter (IBC) enables low switching voltage as well as elevated voltage gain for electric and mobile applications. Fraudulent acts try to improve the dependability of mobile devices, which already have a greater power. The motor receives the output voltage source converter through the vehicle's energy inverter. The engine serves the purpose of FCEVs. Due to the engine, considerably inexpensive and size of cell.

OBJECTIVE

The primary goals observed can be summarised as follows:

We shall examine the neural network-based MPPT controller. We will promptly recognise the improve converter concept. We shall examine the unconventional MPPT topology, modulation approach, and operating standards in detail. We will perform simulation validations of the EV devices.

The following is a summary of the main goals of this study:

1. Examine the use of an MPPT controller based on a neural network.
2. Obtain a thorough understanding of the Boost Conversion idea.
3. Explain the unique modulation technique, MPPT topology, and working principles.
4. Assess simulated validations to ascertain the efficacy of the proposed system.

Literature Survey

Nabil A. Ahmed et. al. 2022, This study improves the overall efficiency of converter. High conversion efficiency more than 97% has been obtained in simulation for wide output power range of 8.2kW to minimum power of 460W. The SSIBC (Soft Switching Multiphase Interleaved Boost Converter) is considered cost effective for high voltage battery in EV application. Due to the soft switching operation of the main and auxiliary switches in in a wide output power control range, the converter has lower switching losses and consequently high conversion efficiency compared to standard hard switching boost converter. Analysis, simulation and design of the converter are verified using PSIM simulation software.

Bhargavi et. al. 2019, This study tackles environmental issues and the finite supply of fossil fuels, which has led to a rise in fuel cell electric cars (FCEVs) in the automotive sector. Electrical components and fuel cell technology have advanced at a rapid pace, allowing for several FCEV advances. Fuel cells provide several advantages, including clean energy production, high dependability, efficiency, and minimal noise. Cells are classified into five categories based on the electrolyte substance: fuel cells with proton exchange membranes (PEMFC), Solid dioxide fuel cell technology (SOFC), phosphoric acid fuel cells (PAFC), fuel cells that are alkaline (AFC), and fuel cells made from molten carbonate (MCFC).

PEMFCs are particularly popular in the automobile sector because to their low temperature of operation and rapid startup time.

El Manaa Barhoumi et. al. 2018, In order to reduce current fluctuations and greatly extend the lifespan of fuel cells with proton exchange membranes, The work that is being described presents a simple method for controlling an interleaved boost converter. A neural network-based regulation is developed and implemented with MATLAB-Simulink to guarantee that the output power stays constant with the intended reference level, especially under significant changes in flow velocity, electrical power, and heat. The main emphasis is on the simplicity of the controller, which was built using MATLAB-Simulink and tested sparingly. Robustness tests are performed on the suggested converter using the neural network controllers to evaluate its performance in the presence of large variations in fuel flow %, supply pressure, temperature, as well as air supply pressure.

K. Jyotheeswara Reddy et. al. 2017, This research looks at the growing need on fuel cell electric cars, or FCEVs, in the automotive sector as a result of stricter fuel economy and greenhouse gas emission requirements for a 26 kW Proton Exchange Membrane fuel cells (PEMFC), which supplies electricity to the vehicle system through a DC-DC boost converter, it recommends utilizing a neural network-based technique. This method is called Maximum Power Point Tracking (MPPT). The recommended MPPT controller uses an algorithm called the Radial Basis Function Networks (RBFN) to accurately track the PEMFC's high-power zone. High-voltage DC into DC conversion and high-speed conversion are required for efficient FCEV operation. The FCEV system uses a three-phase, high-voltage Interconnected Boost Converter (IBC) to obtain a significant voltage gain. In order to reduce input current fluctuations and power device voltage stress, interleaving technology is utilized. The study evaluates the efficacy of FCEV systems using the MATLAB/Simulink platform's fuzzy logic controllers (FLC) against those using RBFN-based MPPT control

Moe Otherward Lwin et. al. 2018, For many years, numerous types of DC-DC converters have been widely used in electrical devices and other purposes. However, typical converters have limits in handling high voltage as well as high current applications. Researchers have attempted to solve these difficulties. This study describes a two-step boosting DC-DC converter intended for solar power systems. The search of control over optimal operation under a variety of settings is ongoing. To produce higher output voltage, the Voltage Type Control approach is used in conjunction with a complex controller. The major goal of this research is to assess the performance of the suggested converter's different parameters utilizing a Neural Network Controller (NNC) and MATLAB/Simulink software.

N. Sudhakar et. al. 2018, With an emphasis in fuel cell electric vehicles (FCEVs), this research examines the high electrical conversion needs and large mechanical maintenance requirements in electric cars. In particular, a novel High-Step Boost Converter (HSBC) designed for outstanding longevity in FCEVs is unveiled. The created converter minimizes input current variations and lessens the effect of voltage on semiconductors components, exhibiting greater power efficiency when compared to traditional equivalents. Additionally, it is suggested that a max power point tracking (MPPT) controllers based on neural networks Neural network application is suggested for 1.26 kW proton exchanged membrane fuel cells (PEMFC) control. The Neural Network uses the Radial Basic Function Networks (RBFN) approach to improve the PEMFC's energy extraction at different temperatures. Using the MATLAB/Simulink platform, the created MPPT control's performance is carefully evaluated and contrasted with fuzzy logic control (FLC).

Existing Configuration

The boost converter is an important component in the electric power condition of fuel cells, operating as a front-end energy conditioner. While typical boost converters are appropriate for applications requiring little power, their limitations in present handling and thermal management render them unsuitable for high-power applications. As a result, the literature presents a number of DC to DC conversion devices with significant voltage gain. High-frequency transformers or isolated converters with coupled inductors aim for a high voltage gain, while the converter duty cycle is regulated for optimum power gain. Despite these attempts, non-isolated single converters are nonetheless more desirable than isolated equivalents.

In order to solve problems related to high voltage gain, this project presents a fuel cell application-specific a three-phase non-isolated connected Boosting Converter (IBC). In order to obtain a significant voltage gain and reduce switching stress, the interleaving method is used. all while improving fuel cell stability & power capacity. An essential component of the fuel cell electric cars (FCEVs) powering them as an inverter, which is used to transfer the voltage generated by the converter to the electric motor. Using an efficient electrical motor considerably decreases both cost and size, which are critical aspects in FCEV design.

Direct current motors were the primary source of power for electric cars in the past, however these motors had drawbacks such high maintenance costs as low efficiency because of brush and rotating parts. In order to get around these problems and get a large voltage gain, a quadratic booster converter with two boost converters was designed. However, the usage of two boost converter might potentially lead to diminished system efficiency. A two-phase flexible conversion coupled with DC-DC protection elements was an alternate method. Unfortunately, the efficiency and dependability of this architecture were worse.

To get a large voltage gain, a boost converter containing a voltage multiplier cell was suggested. However, the voltage increase offered by a single multiplier cell was judged insufficient to power the engine of FCEVs.

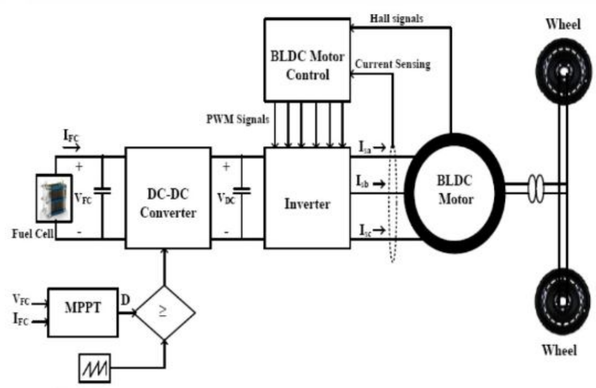


Fig 1. Standard design of electric cars powered by BLDC motors and fuel cells.

Disadvantages of Existing Configuration:

- Inconsistent performance.
- Lower performance.
- High prices.
- A conventional booster converter can be employed as an electrical data connection for low-power applications. However, for high-power packages, an enhance converter may not be suitable because to limited current management capabilities and thermal control issues.
- Utilize built-in dc-dc capabilities to address changeable voltage issues.

Proposed Configuration work

The research proposes a high-voltage acquisition strategy that uses three single-phase interlaced boost converters (IBC) manufactured of power-efficient components to handle low switching difficulties while achieving high voltage increases. This technology improves not only the fuel cell's dependability, but also the power production of the intended FCEV (fuel cell electric vehicle) systems.

The components of the fuel cell electrical vehicle (FCEV) system include a 1.26 kW Proton Exchange Membranes Fuel Cell (PEMFC) coupled with an outstanding performance. Interleaved Boost Converter (IBC), a Voltage Source Inverters (VSI), an a three-phase high-voltage availability, and a Brushless direct-current (BLDC) motor. The PEMFC and the VSI are interfaced with each other via the third phase of the IBC. The system utilizes an algorithm based on a Radial Basis Function Network (RBFN) to provide the fuel cell with a high level of power. Through the VSI, power transfer to the BLDC motor is facilitated by the three-phase IBC. The BLDC motor electronics regulate the conversion that the VSI does, and the driveshaft is coupled to the wheels of the vehicle to provide propulsion.

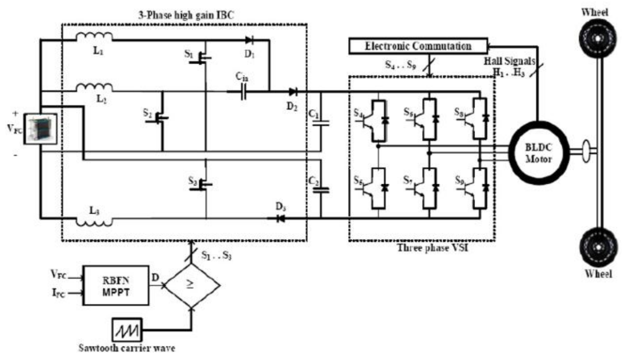


Fig.2. The suggested a three-phase high gain IBC FCEV system powered by a BLDC motor

Advantages Of Proposed Configuration:

- Generation of clean power
- Enhanced reliability
- High operational efficiency
- Minimal noise
- Significant voltage gain.

Applications

- Applications in fuel cells
- Applications in solar power systems.

CONCLUSION

For FCEV applications, a three phases DC to DC converter with a high voltage increase is advised. Minimizing ripples in fuel cell current-injection or voltage stress for power semiconductor switches is the goal of this suggested converter. The article presents the RBFN-Based MPPT Method intended to maximize fuel cell output under different temperature conditions for a 1.26 kW PEMFC. The FLC MPPT controllers and the suggested MPPT technique are contrasted. According to simulation results, When compared to a fuzzy logic controller, the RBFN-based controller for MPPT tracks its maximum power point more quickly. Furthermore, at different fuel cell system temperatures, the performance parameters of the BLDC motor are examined, including electromagnetic speed, velocity, and back magnetic field.

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