Quasi-Z-source boost DC-DC converter with high-voltage gain with supercapacitor and fuel cell-fed vehicles

Sattar Pasha Shaik, Associate Professor EEE, Tkr College of Engineering and Technology(Autonomous), India
A. Archana, UG student, EEE, Tkr College of Engineering and Technology (Autonomous), India
J. Sai Kumar, UG student, EEE, Tkr College of Engineering and Technology (Autonomous), India
A. Sai Kumar, UG student, EEE, Tkr College of Engineering and Technology(Autonomous), India
K. Sharath, UG student, EEE, Tkr College of Engineering and Technology (Autonomous), India

***Abstract*— In this paper, a solar photovoltaic (PV) array, a battery energy storage (BES), a diesel generator (DG) set, and a grid-based electric vehicle (EV) charging station (CS) is utilized to offer non-stop charging in islanded, grid-connected, and DG set connected modes. The CS rather uses a solar PV array and a BES to charge the EV battery However, if the storage battery is depleted or the solar PV array generation is unavailable. However, the power from DG set is drawn in a manner that it always operates at 80%–85% loading. Further still, it should be noted that point of common coupling voltage has to be synchronized with grid/generator voltage so as to provide incessant flow. Here, we are using PI, FUZZY and ANN controllers. By using controllers reduce the THD (total harmonic distortion) values. When reduce the THD, then increase efficiency.**

***Keywords*—EV Charging Station, Solar PV Generation, Controllers,**
Power Quality, DG Set.

INTRODUCTION

The development of clean energy technology is urgently needed to mitigate the issues associated with energy usage, enhance the environment, and reduce the use of fossil fuels. Renewable energy sources are becoming more and more prevalent. The growing number of cars on the road globally is making this a bigger problem and is also contributing to the rise in air pollution. The number of renewable energy-powered vehicles is rising as a percentage of all vehicles, and their growth has been accelerating recently. Because of its high-density current output, ability to generate clean power, and high operating efficiency, fuel cell vehicles play a significant role in the category of clean energy vehicles and have been used extensively in practice. But in contrast to batteries, whose output voltage is generally constant, the fuel cell

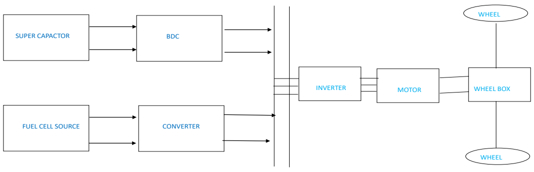
As output current increases, the output voltage falls off quickly. Consequently, a step-up DC-DC converter with a broad voltage gain range must be used to connect it with the inverter's high-voltage DC-link bus. It is easy for the isolated step-up DC-DC converter to obtain a large voltage gain. On the other hand, the energy of the transformer leakage inductance has the potential to result in significant electromagnetic interference, high voltage stress, and increased switching losses.
To save costs, decrease converter volume, and

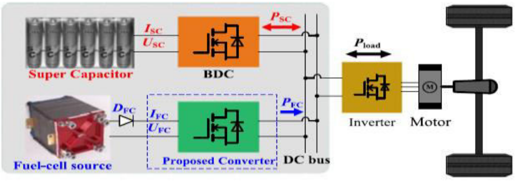
increase conversion efficiency, a non-isolated step-up DC-DC converter is frequently preferable. The traditional boost DC-DC converter is the most often used type of non-isolated step-up DC-DC converter. The converter has a straightforward design with just one power switch. The voltage gain can be unlimited since the power switch's theoretical duty cycle can be changed from 0 to 1. Nevertheless, the voltage gain is constrained because of the circuit's parasitic components. Furthermore, when the output voltage is high, a high-voltage-rated power switch is required since the voltage stress on the power switch is equal to the output voltage.

2.LITERATURE SURVEY

A primary objective of the automotive sector is to enhance the fuel efficiency and performance of vehicles while reducing the proportion of toxic exhaust emissions. One type of vehicle is the fuel cell. of the key technologies (FCV). Fuel cells have many benefits, such as simplicity, low emissions, silent operation, and dependability, which have made them a desirable option for powering automobiles [1]. This paper describes an electric car powered by fuel cells system's power converter. Taking into account the safety criteria and the differences between fuel cells and conventional chemical-power batteries A novel isolated bidirectional topology is proposed. The low cost, straightforward circuit, and high efficiency of the investigated converter are its benefits. Analyses and descriptions are provided for the intricate design and working principles. To demonstrate the viability of the suggested converter, simulation, and experimental waveforms are displayed [2]. In this research, we construct a proportional-integral-derivative (PID) control algorithm to investigate the dynamic behaviour of the power-generating system regarding the proton exchange membrane fuel cell (PEMFC). under load and temperature variation. The model is built using empirical equations that combine three complex dynamics: hydrogen gas reformer, reactant flow dynamics, and electrochemical [3]. This study examined and contrasted three distinct inverters intended for fuel cell application vehicles: a Z-source inverter, a DC-DC boosted PWM inverter, and a regular pulse-width modulation (PWM) inverter. Each of these inverters' constant power speed ratio, total switching device power, and passive component requirements were computed [4].

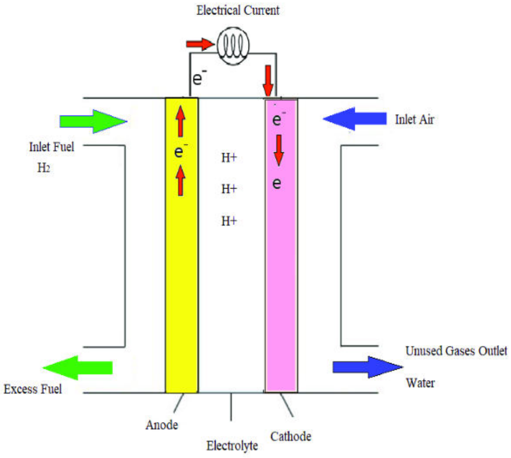
Future fuel cell and hybrid cars may have electrical power systems made up of three voltage nets: high voltage (>200 V) buses, 42 V, and 14 V. To connect the three nets, a soft-switched, bidirectional DC-DC converter requiring just four switches was suggested. A reduced-part DC-DC converter, which keeps all the advantageous aspects of the original topology while lowering the converter cost, is presented in this study [5]. This study presents the use of the voltage multiplier technique to traditional non-isolated using DC-DC converters to reach zero current switching turn-on, a reduction in the maximum switch voltage, and a high step-up static gain. The voltage multiplier also functions as a regenerative clamping circuit, which minimizes the reverse recovery current problem of the diodes and lowers the layout and EMI generation issues [6]. The solution for power electronics device monitoring and control in telecommunications facilities is described in this study. Using a single-user application, centralized power supply system monitoring allows for the operation of all system devices to be monitored. The functioning of passive components, which together utilizing the power electronics devices make up the power system, is monitored in addition to the operation of individual devices [7]. In this work, a diagnostic instrument to assess the PEMFC's level of hydration was created. The PEMFC's impedance was represented by the Randels impedance model improved by a CPE, and Laplace's approach converted the complex impedance model into a real model of the PEMFC's explicit fractional order [8]





3.2.1 FUEL CELL SOURCE

An apparatus that produces electricity through a chemical reaction called a fuel cell. Each fuel cell has two electrodes that are referred to as the cathode and anode, respectively. The electrodes are the sites of the processes that result in electricity. In addition, a catalyst quickens the reactions at the electrodes and an Electrolyte transports electrically charged particles between the electrodes in every fuel cell. The primary fuel for fuel cells is hydrogen, but oxygen is also needed. Fuel cells are particularly appealing because they produce electricity with very little pollution; in the end, most of the hydrogen and oxygen used to produce electricity combine to make water, which is a harmless consequence. One technical point: a single fuel cell produces very little direct current (DC) electricity.



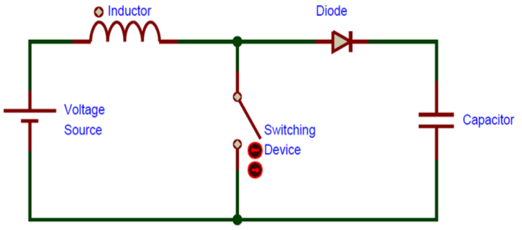
Development of fuel cells

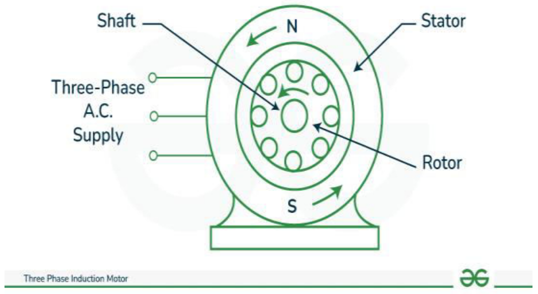
Beginning with the early days of electrochemistry, the basic idea of a fuel cell, or battery, was developed. William Grove, a British physicist, employed platinum electrodes in 1839 the reaction of hydrogen and oxygen. Due to the use of a porous non conductor to store the electrolyte, two British chemists, Carl Langer and Ludwig Mond, who was born in Germany, created a fuel cell in the late 1880s that had superior endurance. Wilhelm Ostwald, a German chemist, suggested electrochemical cells—in which carbon is converted to carbon dioxide by oxygen a replacement for heat-engine generators after it was discovered that using a carbon basis allowed for the use of far less platinum.

Fritz Haber and Walther H. Nernst in Germany and Edmond Bauer in the United States in the early 1900s Cells were used in experiments in France using a solid electrolyte. Nonetheless, low success rates and exorbitant expenses discouraged enthusiasm in carrying out further development work. At the University of Cambridge, British engineer Francis Thomas Bacon and colleagues labored from 1932 until well after World War II to develop workable hydrogen-oxygen fuel cells with an alkaline electrolyte. The research led to the development of gas-diffusion electrodes, which successfully maintain regulated contact between an aqueous electrolyte on one side and the fuel gas on the other. The results of experimental work on solid electrolytes for high-temperature fuel cells and both high- and low-temperature alkaline electrolyte hydrogen-oxygen cells were published by Soviet Union's O.K. Davtyan by the middle of the 20th century. High-performance and reliable power sources are essential. In the 1950s and 1960s, plans for manned space missions and space satellites opened up fascinating new avenues for fuel cell development.

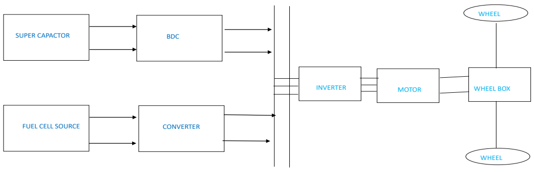
While other researchers developed the extremely thin Teflon-bonded carbon-metal hybrid electrode, J.A.A. Ketelaar and G.H.J. Broers of the Netherlands produced molten carbonate cells with magnesium oxide pressed on the electrodes.

The creation of novel materials and numerous other technological developments were essential to the development of functional fuel cells that are used today. It is anticipated that fuel cells will become a more appealing alternative power source due to advancements in electrode materials and construction and the growing expense of fossil fuels, particularly in Japan and other nations with limited non renewable energy supplies. At the start of the twenty-first century, a lot of electrical devices a large number of electrical equipment producers were creating fuel cell-based power production.





4:PROPOSED CIRCUIT TOPOLOGY

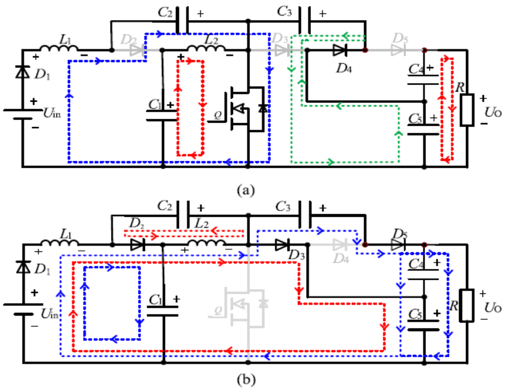


4.1.1 Analysis of Operating States

Assuming that T is the switching period, d is the power switch Q's duty cycle, and d × T is the interval of S = 1, the suggested converter has two states according to the states that switch of the power switch Q: S = 1 and S = 0. The suggested converter's current flow in both switching stages is depicted in Fig. 2. The main operating waveforms of the suggested converter during a switching period are displayed in Fig. 3. S is equal to 1. Fig. 2(a) displays the analogous circuit of the suggested converter in the switching state S = 1.

The proposed converter's essential working waveforms, displayed in Figure 3, indicate that diodes D2, D3, and D5 are switched off and Q is activated. Energy is transferred from the input voltage. to the inductor L1 via the capacitor, the diode D1, and the power switch powered by source UIN C2. Q. C1 uses Q to transmit energy to L2. While C5 and C4 in series supply the energy for the load, capacitor C5 sends energy to C3 via D4 and Q.

2) S = 0: Fig. 2(b) displays the corresponding circuit of the suggested converter in the switching state S = 0. The proposed converter's major operating waveforms, displayed in Figure 3, indicate that Q is switched off and D2, D3, and D5 are turned on. Energy is transferred from Uin and L1 to C1 via D1 and D2. L2 uses D2 to transmit energy to C2. Energy is transferred from Uin, L1, and L2 to C5 via D1, D2, and D3. Concurrently, Energy is moved to C4. and C5 in series by Uin, L1, L2, and C3 in series.

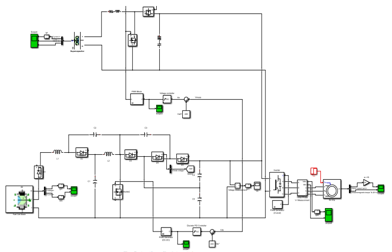


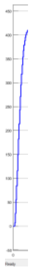
(a)

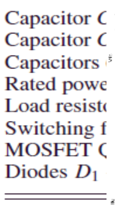
(b)

5.simulation results

RESULTS AND DISCUSSION:







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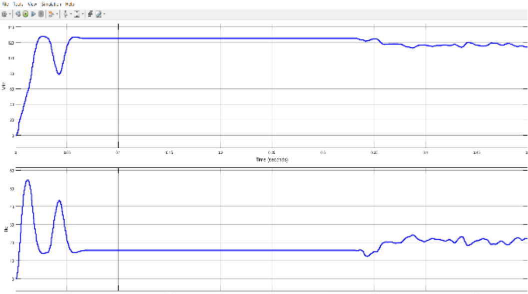
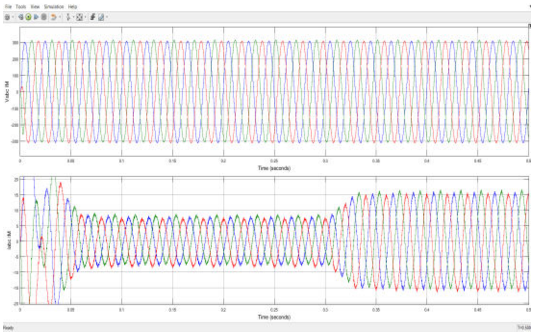


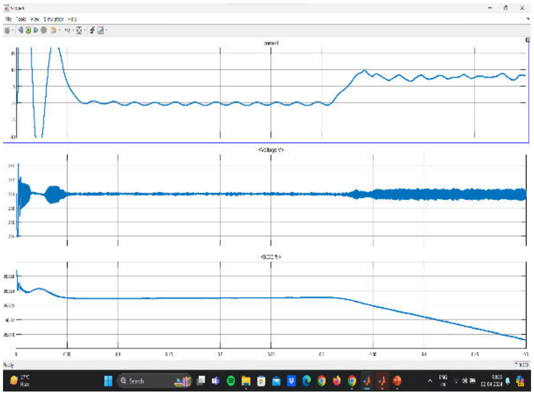
1 SIMULATION INVERTER OUTPUT

The graph in Figure 5.3 shows the waveform of the inverter output waveform x-axis representing time in seconds and the Y-axis representing voltage in volts.



SUPERCAPACITOR OUTPUT

The graph in Figure 5.4 shows the waveform of super capacitor output x-axis representing time in seconds and the Y-axis representing voltage in volts.



FUEL CELL OUTPUT

The graph in Figure 5.6 shows the waveform of fuel cell output with the X-axis represents Time in second and the y-axis representing the voltage

CONCLUSION

This work suggested the topology of a quasi-Z-source boost dc-dc converter using a switching capacitor. The suggested converter achieves a high-voltage gain of 2/(1 − 2d) with the duty cycles for the power switch between 0 and 0.5 while keeping all the benefits of the conventional quasi-Z-source topology, such as continuous input current and common ground between the input voltage source side and the load side. Furthermore, every component in the suggested converter has a maximum voltage stress that is equal to half of the output voltage. Moreover, the quasi-Z-source network's capacitor voltages can clamp the output capacitor voltages at half of the output voltage. For this reason, the suggested converter is appropriate for fuel cell vehicle power interfaces

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