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A High Gain Compact Module Bidirectional Dc-Dc Converter

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ABSTRACT: This project presents a non-isolated bidirectional DC-DC converter (BDDC) topology using a switched inductor-switched capacitor (SISC) module. The bidirectional power transfer capability facilitates its application mainly in microgrids and electric vehicles. The cells incorporate a switched inductor (SI) and a switched capacitor (SC) which enables high gain voltage generation without the use of bulky transformers. It benefits from a wide voltage gain range and reduces voltage stress on the power switches. Furthermore, the proposed (SISC-BDDC) can operate in both boost and boost modes. Simulations are performed for both modes using the MATLAB/Simulink platform

KEYWORDS: BDDC,Isolated converters,EV

I.INTRODUCTION

A bidirectional converter is a power electronic device that can convert electrical energy from one form to another in a bidirectional manner. This means that it can convert energy from DC to AC or vice versa, depending on the requirements of the system. Bidirectional converters are particularly useful in applications where energy needs to be stored and then fed back into the system at a later time, such as in battery energy storage systems or regenerative braking systems in electric vehicles. One of the key features of bidirectional converters is their ability to control the flow of energy in both directions. This is achieved through the use of power electronic devices such as transistors and diodes, which can switch on and off at high speeds to control the flow of current. By adjusting the timing and duration of these switches, bidirectional converters can regulate the voltage and current output to meet the requirements of the system. In renewable energy systems, bidirectional converters are often used to connect energy sources such as solar panels or wind turbines to the grid. These converters can take the DC output from the renewable energy source and convert it to AC power that is compatible with the grid. They can also operate in reverse, converting AC power from the grid back to DC to charge batteries or store excess energy for later use. Another important application of bidirectional converters is in electric vehicles. These converters are used to convert energy from the batteries to power the electric motor, as well as to convert energy from regenerative braking back to the batteries. By efficiently managing the flow of energy in both directions, bidirectional converters can help improve the overall efficiency and performance of electric vehicles. Bidirectional converters also play a key role in grid-connected energy storage systems. These systems store excess energy from the grid during off-peak hours and then feed it back into the grid during peak demand periods. Bidirectional converters are used to control the charging and discharging of the energy storage system, ensuring that energy is efficiently stored and released when needed. One of the key challenges in implementing bidirectional converters is the need for efficient control algorithms. These algorithms are used to regulate the flow of energy in both directions, ensuring that the converter operates efficiently and safely. By using advanced control techniques such as pulse-width modulation (PWM) and feedback control loops, bidirectional converters can achieve high levels of efficiency and reliability in a wide range of applications.

In this paper a high gain Switched inductor switched capacitor compact module bidirectional converter with closed loop PI controller is proposed. Switched inductor switched capacitor (SISCC) compact module bidirectional DC-DC converters are becoming increasingly popular in power electronics due to their high efficiency, compact size, and bidirectional power flow capabilities. These converters combine the advantages of switched inductor and switched capacitor topologies to achieve efficient power conversion in a small form factor. One of the key advantages of SISCC converters is their ability to handle bidirectional power flow, making them ideal for applications where power can flow in both directions, such as This bidirectional capability allows for efficient power transfer between different energy sources, such as batteries and supercapacitors, without the need for additional components or complex control algorithms.

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II. LITERATURE REVIEW

[1] Presenting a scalable, high-performance DC–DC converter topology, the study significantly advances the subject of power electronics. It provides a strong basis for additional research and development while addressing important issues in voltage boost applications. It is an invaluable resource for researchers and engineers working on sophisticated power conversion systems because of its mix of theoretical rigour and practical validation.

[2] The authors offer a DC–DC boost converter made specifically to fit fuel cell car needs. The suggested converter has the capacity to provide a high voltage gain and function well across a broad range of input voltages. This is especially important for fuel cell applications, since the nature of fuel cells allows for large variations in input voltage.

This research contributes significantly to the development of power electronics for fuel cell vehicles. The authors propose a converter design that could contribute to wider use of fuel cell technology in the automotive industry by solving the problems of wide input range and For researchers and engineers working in the field, this research is an invaluable resource due to its extensive validation through theory, simulation, and experimentation.

[3] In order to meet the needs of applications that need high voltage gain and numerous power sources, the authors provide a novel DC to DC converter topology that can handle multiple inputs and outputs. When power from various sources (such as solar panels and wind turbines) needs to be combined and converted to higher voltage levels, systems like renewable energy applications are a good fit for this architecture.

A very flexible and effective DC–DC converter topology is introduced in this study, which significantly advances the field of power electronics. Key issues in renewable energy and other applications are addressed by the multi-input multi-output capabilities and high voltage gain. This paper is an invaluable resource for researchers and engineers looking to build enhanced power conversion systems because of the complete validation achieved through theoretical, simulation, and experimental work.

[4] To maximize voltage gain and reduce switching losses, the authors propose a high-gain DC-DC converter using ZVZCS and interleaved operation. In applications requiring high voltage boost, this design is intended to increase power conversion efficiency and reliability. By providing high efficiency and high capacity gain. The DC-DC converter uses interleaving and ZVZCS techniques, this work is a significant addition to the field of power electronics. With its potential for efficiency and reliability, this new design solves critical problems in voltage step-up applications. This article serves as a useful resource for researchers and engineers working on advanced energy conversion systems thanks to comprehensive validation achieved through theoretical work, modeling and testing.

[5] Using connected inductors, voltage multipliers, and interleaving, the authors propose a high-boost DC-DC converter. Through this design, the overall power conversion efficiency in renewable energy applications will be increased, switching losses will be reduced, and voltage gain will be increased. Regarding the advancement of complex DC-DC converters for renewable energy systems, the paper has made a significant contribution. The main obstacles in achieving high voltage gain and efficiency are addressed by the proposed high-boost interleaved converter with voltage multiplier and connected inductor. The extensive validation achieved through theoretical, modeling and experimental work makes this article an invaluable resource for engineers and researchers working on energy conversion systems

III.PROPOSED TOPOLOGY

The inductor switched capacitor (SISC) module is used in the non-isolated bidirectional DC-DC converter (BDDC) topology of this article. Its main applications in microgrids and electric cars are enabled by its ability to transmit bidirectional current. This figure 1 shows the basic circuit diagram of the setup from the base documentation.

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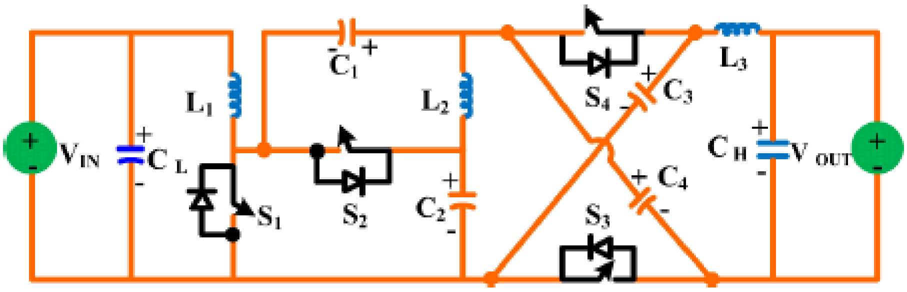

Figure .1 Compact high gain module Basic circuit diagram of a bidirectional DC-DC converter

Several hypotheses were considered to simplify the analysis of SISC-BDDC.(1) All the energy storage components of SISC-BDDC, namely inductors L1, L2, L3 and capacitors C1, C2, C3, C4, CH, CL, are perfect except the resistance of switches (RDS)(2) Linearity when the induced current and capacitor voltage increase or decrease; (3) Constant voltage of the capacitor. SISC-BDDC in boost and step-down modes for continuous conduction mode (CCM) operation is shown with representative waveforms in Figs.

The basic operation of a SISCC converter involves switching the input voltage across a switched inductor and a switched capacitor to transfer power bidirectionally between two DC sources. The input voltage is first applied across the switched inductor, which stores energy in its magnetic field. The energy stored in the inductor is then transferred to the switched capacitor during the switching cycle. The capacitor then delivers the energy to the output load, allowing power to be efficiently transferred between the input and output sources.

IV.SIMULATION MODEL

Figure 2 shows the simulation diagram of high gain bidirectional converter which is simulated for an input voltage of 12V DC and 1.2 mH,5mH,6mH Inductors and 470 µF,520 µF capacitors s reveals that it has a potential to be able to convert the various network conditions into a performance improvement.

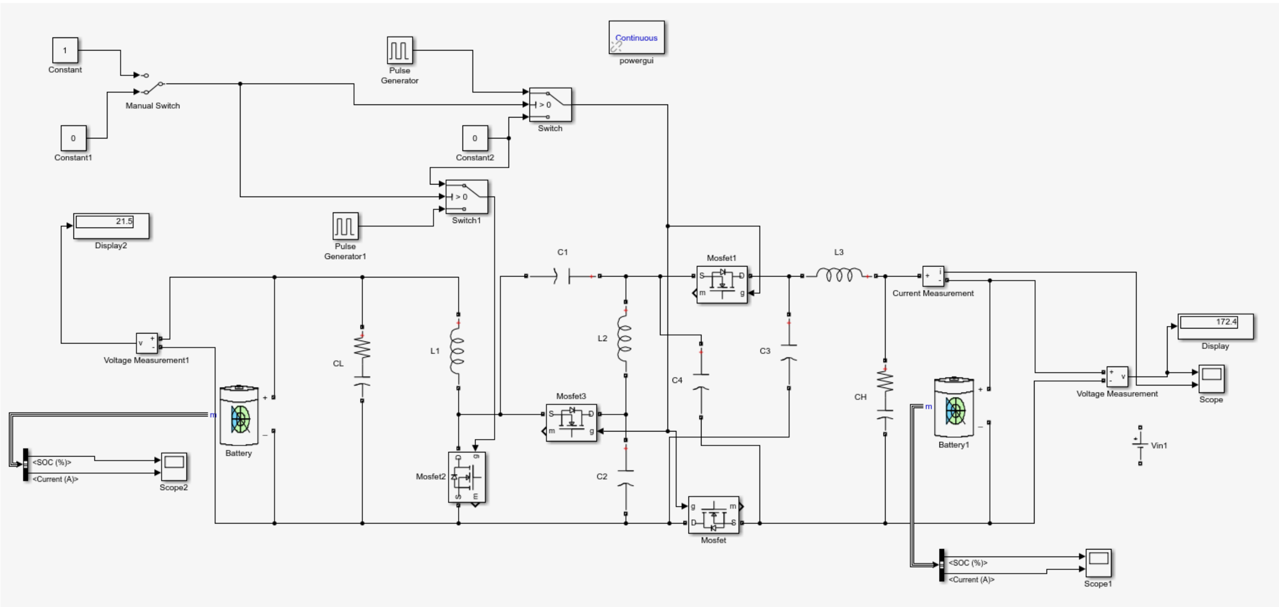

Figure 2 Simulation diagram of the high gain bidirectional converter

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Components and parameters	Parameter value
Input voltage	20V
Inductor L1	1.2mH
Inductor L2	5mH
Inductor L3	6mh
Swithcing Frequency	20KHz
Capacitor C1,C2	470 µF
Capacitor C4,CL,CH	520 µF

Table 1: Simulation system Parameters

V. RESULTS

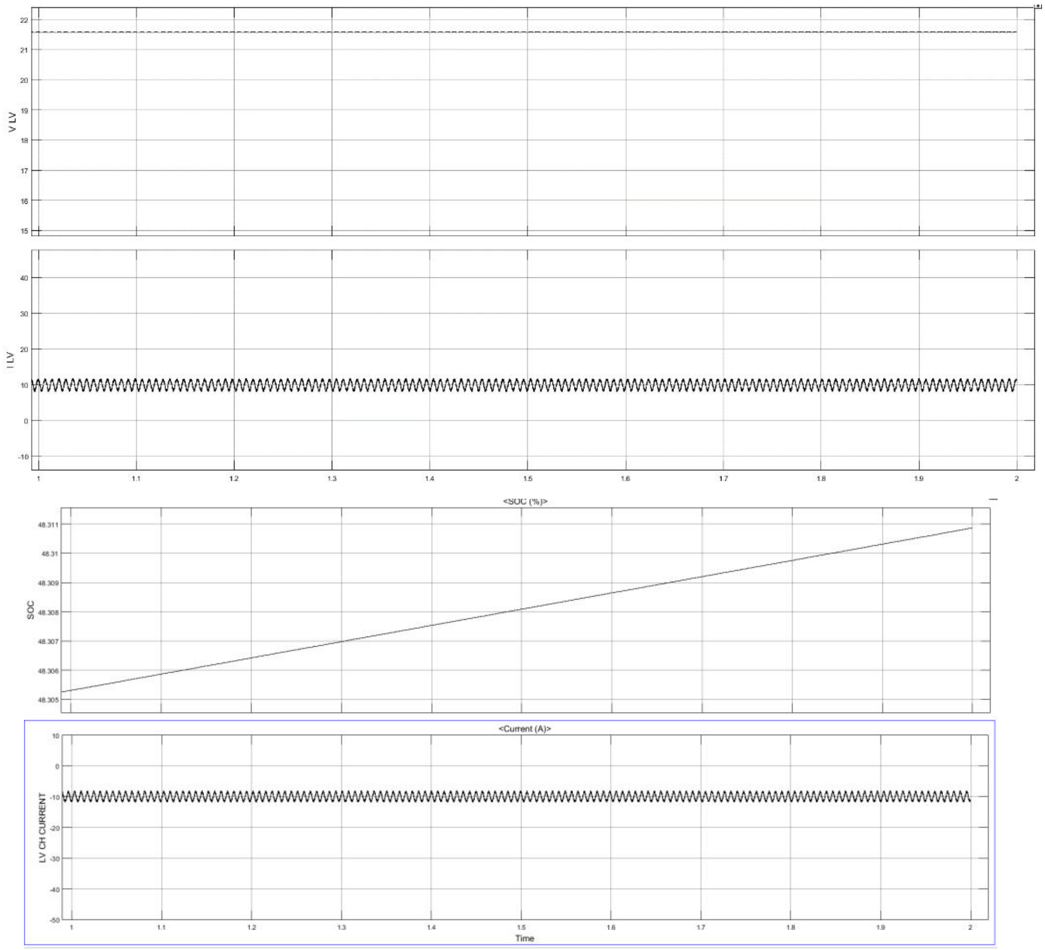

Figure 3 Simulation Results Buck mode

VI.CONCLUSION

In this paper, a new non-isolated SISC-BDDC is proposed. Four active power switches enable the SISC-BDDC to be compact and achieve a wide voltage amplification range in boost and step-down modes. Its circuit is very simple. The proposed converter has been subjected to extensive theoretical studies, including small-signal models and testing of its mode of operation. To verify the stability of the converter, a controller design technique (small signal model) has been mentioned. Then, to confirm the theoretical analysis, simulation and experimental results are given under different operating conditions. Compared to other similar topologies, lower voltage and current constraints on the switches have been demonstrated. The good dynamic performance of SISC-BDDC is a good replacement for electric cars, microgrids and renewable energy sources.

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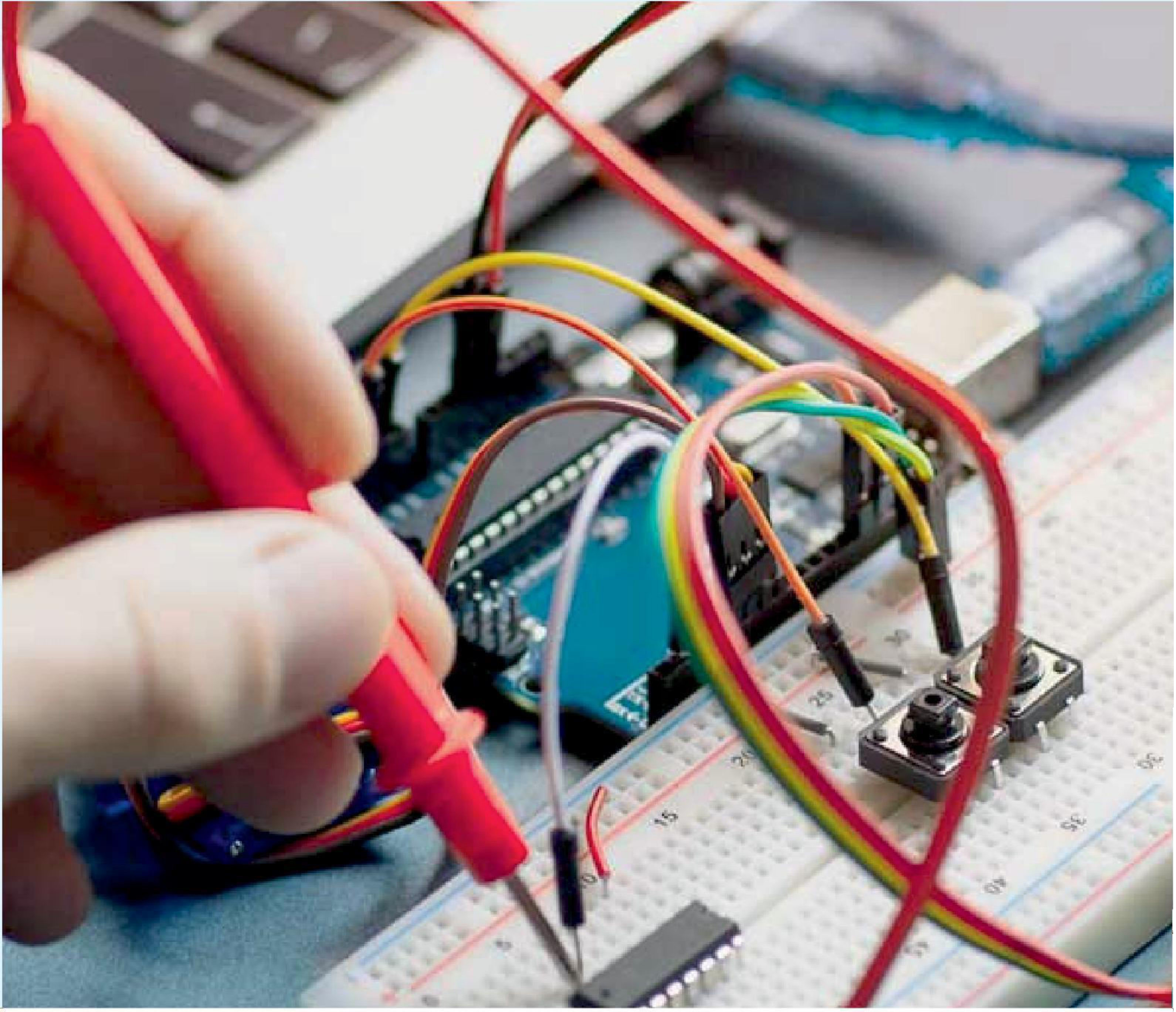

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