IJAREEIE

e-ISSN: 2278-8875
p-ISSN: 2320-3765

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

Volume 10, Issue 7, July 2021

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 7.282

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 7.282|

|| Volume 10, Issue 7, July 2021 ||

| DOI:10.15662/IJAREEIE.2021.1007070 |

Soft Switching High Step-Up/Down Bidirectional DC-DC Converter

Blesswin Epron M, Lakshanakugan M, Nareshkumar S, Vasanthkumar S, Mr. S.Vijayasarathi,

UG Student, Dept. of E.E.E, Panimalar Institute of Technology, Chennai, India

Assistant Professor, Dept. of E.E.E, Panimalar Institute of Technology, Chennai, India

ABSTRACT:A non-isolated bidirectional DC-DC converter with high voltage gain, low voltage stress, low component count and soft switching features is presented in this paper. In this topology, coupled inductors and voltage multiplier cells are merged to achieve high step-up/down voltage gain. Also, due to using active clamp circuits, the voltage stress of power switches is relatively low and low voltage switches with low on-resistance can be employed to reduce the conduction losses. Furthermore, zero voltage-switching is accomplished in both high step-up and high step-down modes for all power switches and due to zero current switching operation of all antiparallel diodes, the reverse recovery losses is reduced. This converter is usually used for low-voltage applications, due to simple control and low cost. In order to verify the theoretical analysis and the converter performance, a 200 W prototype circuit of the proposed converter is implemented.

KEYWORDS: Bidirectional DC-DC Converter, Transformer, Full Bridge Rectifier, MOSFET, Microcontroller, Single Pulse, Typical Waveform, Filter Capacitor, Hybrid System, IBDC,NIBDC, Multiple Pulse.

I. INTRODUCTION

The use of renewable energy resources has been increased to save the environment and remaining fossil fuel and the requirement of storing the energy is also increased. In many applications like electric vehicles the need of interfacing of energy storage with load and source is increased for a reliable and efficient system. Bidirectional dc to dc converter is the main device used to interface the Battery and super capacitor as a storage device to increase the system reliability. Moreover, in electric vehicle bidirectional dc-dc converters used for capturing the kinetic energy of motor and charging the battery during regenerative-breaking by reverse flow of energy.

II. LITERATURE SURVEY

[1] M. Ehsani, Y. Gao, and J. M. Miller, "Hybrid electric vehicles: architecture and motor drives" Electric traction is one of the most promising technologies that can lead to significant improvements in vehicle performance, energy utilization efficiency, and polluting emissions. Among several technologies, hybrid electric vehicle (HEV) traction is the most promising technology that has the advantages of high performance, high fuel efficiency, low emissions, and long operating range. Moreover, the technologies of all the component hardware are technically and markedly available. At present, almost all the major automotive manufacturers are developing hybrid electric vehicles, and some of them have marketed their productions, such as Toyota and Honda. This paper reviews the present technologies of HEVs in the range of drivetrain configuration, electric motor drives, and energy storages.when the nodes have sufficient amount of energy to transmit the message otherwise message will be dropped.

[2] D. Han, J. Noppakunkajorn, and B. Sarlioglu, "Comprehensive efficiency, weight, and volume comparison of SiC and Si-Based bidirectional DC-DC converters for hybrid electric vehicles,"

Silicon carbide (SiC)-based switching devices provide significant performance improvements in many aspects, including lower power dissipation, higher operating temperatures, and faster switching, compared with conventional Si devices. However, tradeoffs in efficiency, size, and weight between Si- and SiC-based converters are still unclear in the literature. In this paper, a bidirectional dc-dc converter that is suitable for hybrid or electric vehicle application is studied based on three sets of device combinations, e.g., all-silicon [conventional silicon insulated-gate bipolar transistors (IGBTs) and silicon PN diodes], hybrid (silicon IGBTs with SiC Schottky diodes), and all-SiC (SiC metal-oxide-semiconductor field-effect transistors with SiC Schottky diodes). At the switching frequency of 20 kHz, comparative analyses regarding the power loss reduction of power devices and efficiency improvements are carried out

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 7.282|

|| Volume 10, Issue 7, July 2021 ||

| DOI:10.15662/IJAREEIE.2021.1007070 |

for the converters. Possible size and weight reduction is also investigated by increasing the operating frequencies of hybrid and all-SiC converters while reducing the capacitance and inductance values.

[4] M. A. Abusara, J. M. Guerrero, and S. M. Sharkh, "Lineinteractive UPS for microgrids,"Line-interactive uninterruptible power supply (UPS) systems are good candidates for providing energy storage within a microgrid to help improve its reliability, economy, and efficiency. In grid-connected mode, power can be imported from the grid by the UPS to charge its battery. Power can be also exported when required, e.g., when the tariffs are advantageous. In stand-alone mode, the UPS supplies local distributed loads in parallel with other sources. In this paper, a line-interactive UPS and its control system are presented and discussed. Power flow is controlled using the frequency and voltage drooping technique to ensure seamless transfer between grid-connected and stand-alone parallel modes of operation. The drooping coefficients are chosen to limit the energy imported by the UPS when reconnecting to the grid and to give good transient response. Experimental results of a microgrid consisting of two 60-kW line-interactive UPS systems are provided to validate the design.

[5] X. Xiaoling, C. K. Tse, and R. Xinbo, "Bifurcation analysis of standalone photovoltaic-battery hybrid power system"Standalone photovoltaic-battery hybrid power systems are attractive renewable power generation systems, a popular form of which is based on a photovoltaic system and a battery connected to an output dc bus via a buck converter and a bidirectional buck/boost converter, respectively. Due to variation of the available sunlight intensity, the battery voltage and load condition, the system's structures and operating modes are switched from time to time. The dynamic behavior is thus quite complex, and the design for stable operation of the system requires consideration of the stability conditions for all possible operating modes. This paper studies the dynamic behavior of this system and reveals the smooth and non-smooth bifurcation phenomena. Under certain conditions, when the system switches its operating mode, a non-smooth bifurcation, manifested as a jump from stable to unstable behavior, has been observed and verified with full-circuit simulations. Moreover, a detailed analysis based on averaged modes is performed to identify the two types of bifurcation and evaluate the stability boundaries of the system. The results provide useful insights and information about the behavior of the system and the interacting effects of control parameters on the design of the control loops.

III. SYSTEM ANALYSIS

A. *Existing System:*In the existing system, The Isolated Bidirectional DC-to-DC converter (IBDC) allows power flow in both forward and reverse directions. Such a converter is specially suited for high power applications because it converts a fixed DC battery voltage into a higher DC voltage. Thus IBDC can able to provide safety standards of galvanic isolations. But when come to low power applications IBDC will not much efficient when compare to NIBDC because IBDC is difficult to control and heavy weight because presence of high frequency transformer is must in IBDC, which is bulky and heavier. The drawback of this system is the high voltage spikes provoked by the transformer leakage inductance when the boost converter is switched. Thus the role of NIBDC will be main part in low power applications.

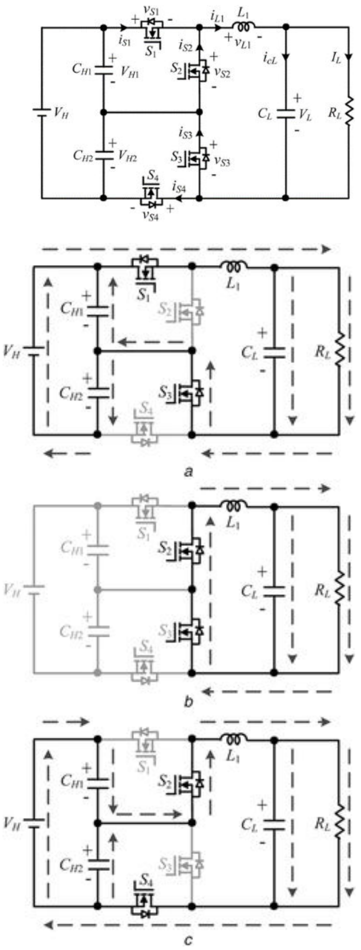
B. *Proposed System:*In the proposed system, the non-isolated bidirectional DC to DC converter (NIBDC) also allows power flow in both forward and reverse directions. These type of converter is used for low power applications, mainly in renewable energy system. This converter does not use high frequency transformer to provide any electrical isolation between source and load. NIBDC are more efficient in low power applications because these converters are easy to control and light weight due to absence of transformer. We designed this NIBDC topology which is more beneficial than the IBDC topologies in renewable energy applications.

C. *Step-Down Mode:* In the step-down mode, the equivalent circuit of the proposed converter is shown in Figure 6.1.1. The pulse-width modulation (PWM) technique is used to control the switches S1 and S4. The switches S2 and S3 are used for the synchronous rectifiers. Figure shows some typical waveforms in continuous-conduction-mode (CCM) operation. The operating principles and steady-state analyses are described as follows:

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 7.282|

|| Volume 10, Issue 7, July 2021 ||

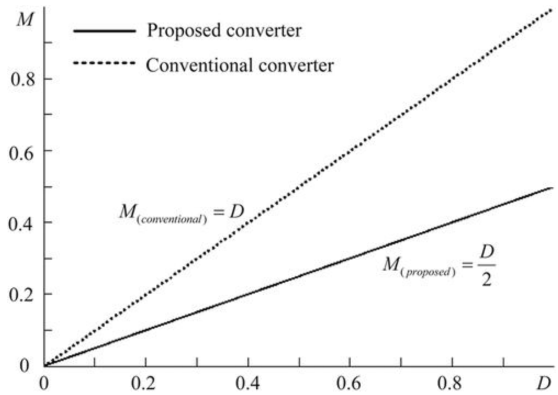
| DOI:10.15662/IJAREEIE.2021.1007070 |



Step-Down Mode Operations

The current through the inductor L_1 is obtained as,

$$i_{L_1}^{\mathrm{I}}(t) = i_{L_1}(t_0) + \frac{1}{L_1}\left(\frac{V_{\mathrm{H}}}{2} - V_{\mathrm{L}}\right)(t - t_0)$$



Voltage Gain Graph

D. *Step-Up Mode*: In the step-up mode, the equivalent circuit of the proposed converter is shown in Figure 6.2.1. The PWM technique is used to control the switches S2 and S3. The switches S1 and S4 are used for the synchronous rectifiers. Figure 6.2 .2 shows some typical waveforms in CCM operation. The operating principles and steady-state analyses are described as follows: The current through the inductor L1 is obtained as

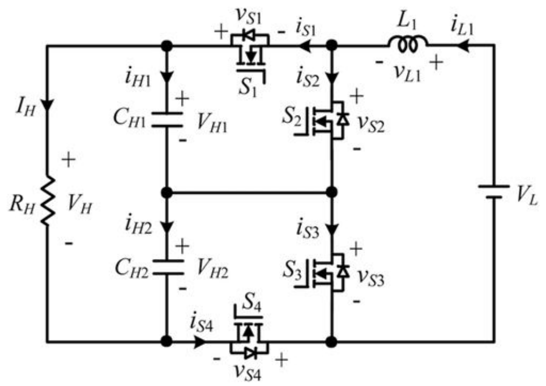
$$i_{L_1}^{\mathrm{I}}(t) = i_{L_1}(t_0) + \frac{V_{\mathrm{L}}}{L_1}(t - t_0)$$

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering (IJAREEIE)

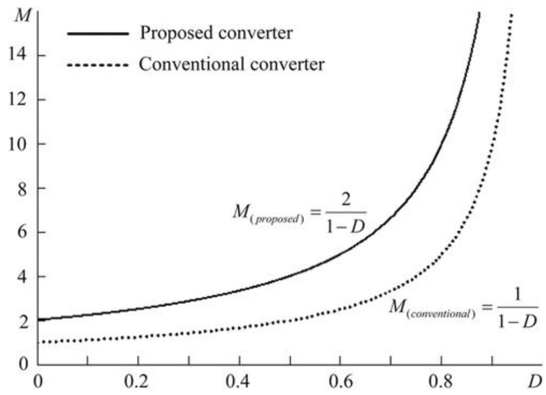
| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 7.282|

|| Volume 10, Issue 7, July 2021 ||

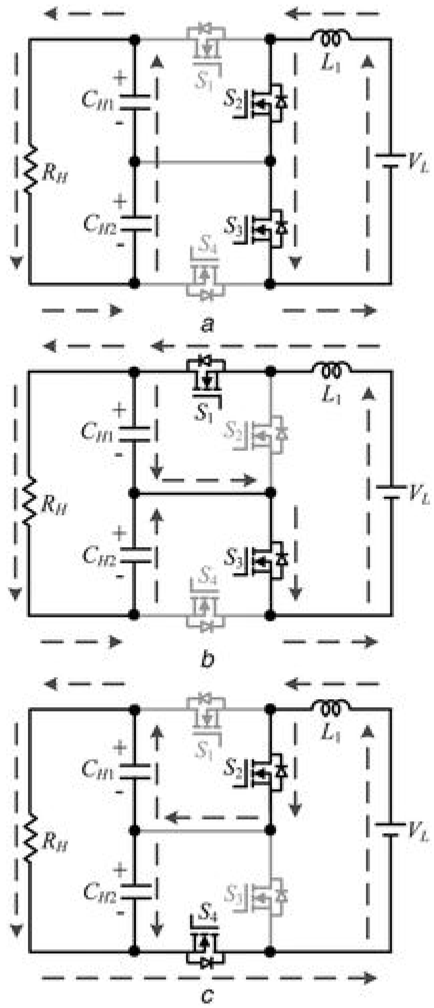
| DOI:10.15662/IJAREEIE.2021.1007070 |



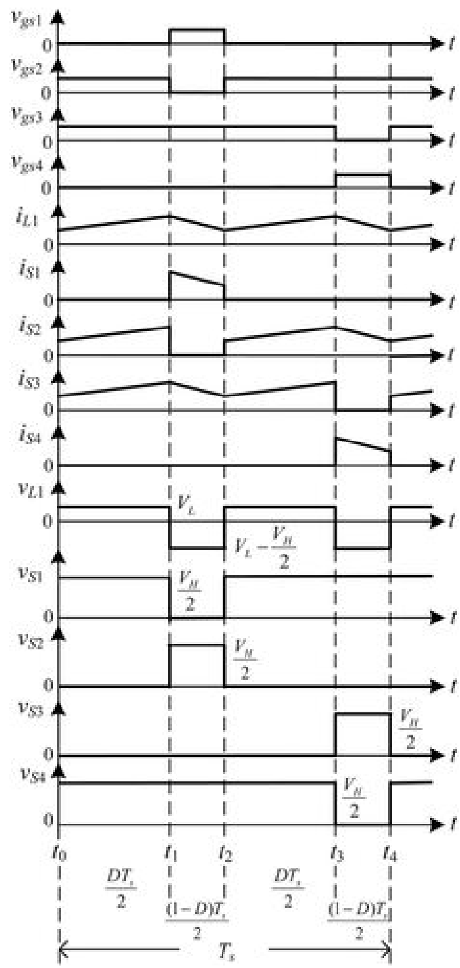
Step-Up Mode Equivalent Circuit



Voltage Gain Graph



Step-Up Mode Operations



Step-Up Mode Typical Waveform

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 7.282|

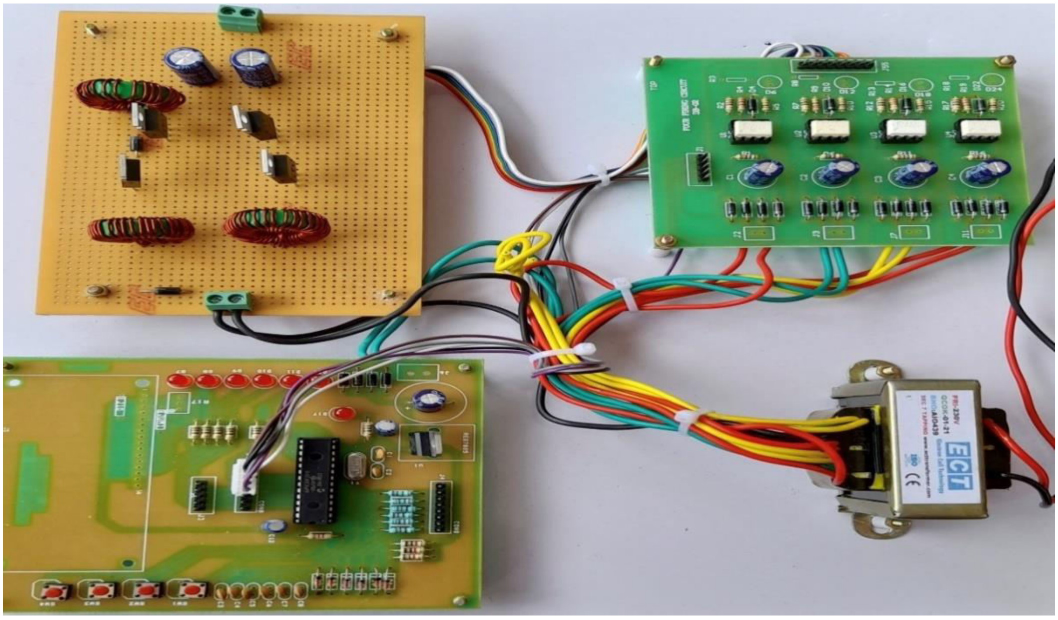
|| Volume 10, Issue 7, July 2021 ||

| DOI:10.15662/IJAREEIE.2021.1007070 |

IV. RESULTS & DISCUSSION

In power supply circuit **step-downtransformer** plays a vital role by consuming 230Volt, 50Hz AC supply from single phase source and convert it into 12Volt AC supply. This 12Volt AC supply is given to controller circuit, driver circuit, and converter circuit.Further that AC supply is convert into DC supply using **rectifier** circuit therefore, here we get 12Volt pulsating DC supply. **IN4007 diode** is used in this rectifier circuit for converting AC to DC voltage. But here we need pure form of DC voltage instead of pulsating DC voltage, so for that **470 µF, 25Volt** electrolytic type capacitor is used as filter circuit which can convert pulsating 12Volt DC into pure form of 12Volt DC supply. Here we can't provide 12Volt DC directly to microcontroller so we convert that 12Volt DC into 5Volt DC by using **IC7805 voltage regulator**. Hence that 5Volt supply will be provide to microcontroller "**DSPIC30F2010**". Since we using DSPIC30F2010 microcontroller which contain 28 pins where 12^{th} and 13^{th} pin is connected to the **crystal oscillator.** This crystal oscillator will generates single clock pulse with operating frequency of **10MHZ** with **amplitude of 5Volt**.

NIBDC HARDWARE KIT



NIBDC MEASUREMENT VALUES

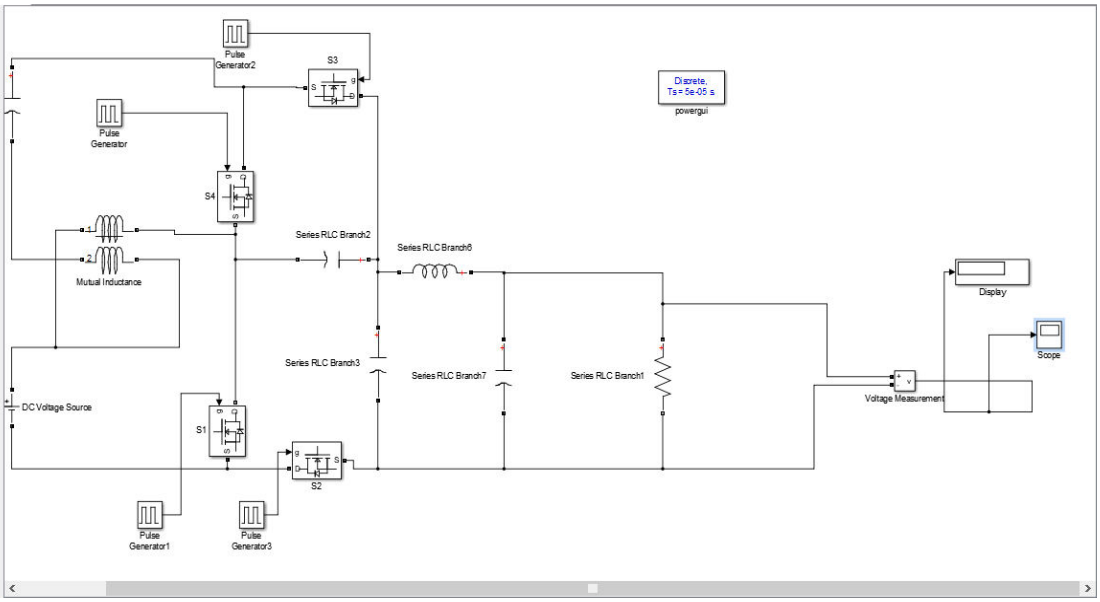
VOLTAGE AT INPUT TERMINALVOLTAGE AT OUTPUT TERMINAL

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 7.282|

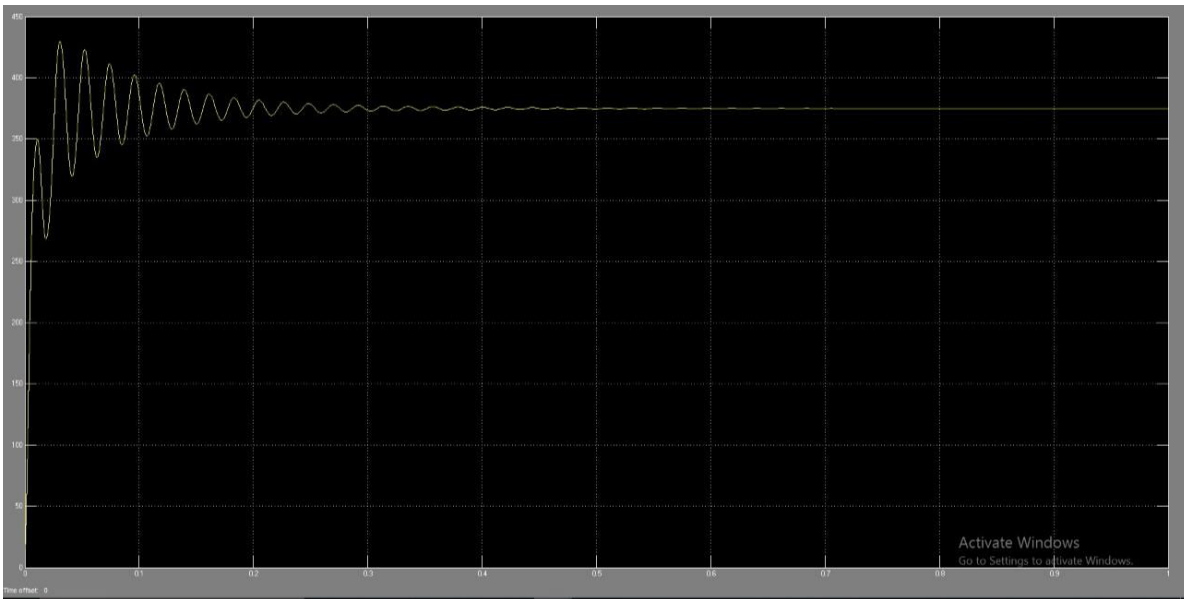
|| Volume 10, Issue 7, July 2021 ||

| DOI:10.15662/IJAREEIE.2021.1007070 |

SIMULATION DIAGRAM



SIMULATION OUTPUT



V. CONCLUSION AND FUTURE WORK

In this paper, a new non-isolated bidirectional DC-DC converter for high step-up/down applications is proposed. In this topology, coupled inductors and voltage multiplier cells are combined to improve the voltage conversion ratio and achieve soft switching performance for all switches. Moreover, the voltage gain is extended in comparison to the conventional buck-boost BDC. Also, the reverse recovery problem of all antiparallel diodes is alleviated and the prototype converter succeeded high efficiency in both high step-up and high step-down modes. In addition, all switches can be controlled with conventional PWM method. The comparison with other counterpart topologies has revealed the

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 7.282|

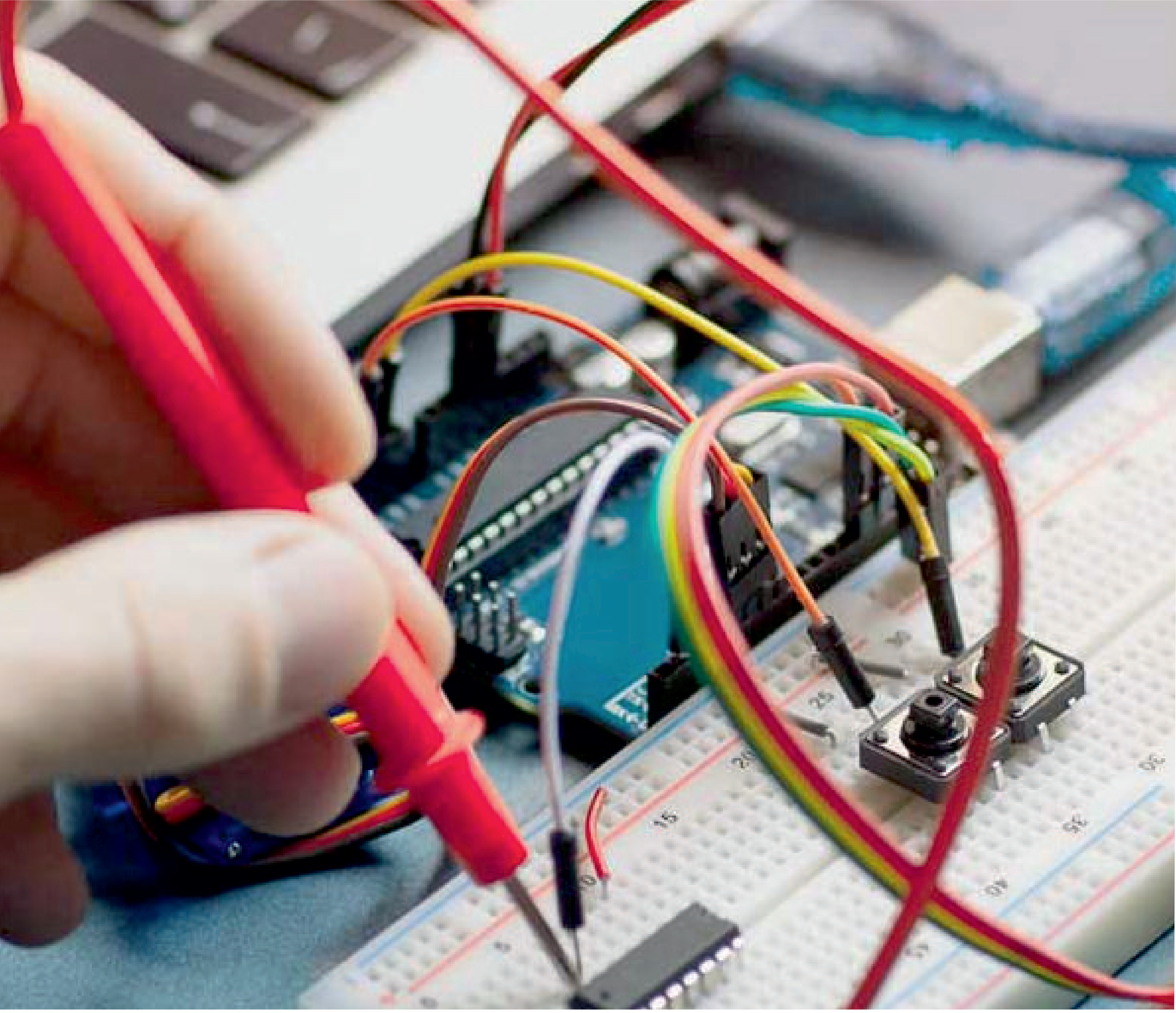
|| Volume 10, Issue 7, July 2021 ||

| DOI:10.15662/IJAREEIE.2021.1007070 |

high performance of the proposed converter. Finally, the experimental results of implemented converter have validated the theoretical analysis and justified the converter operation.

REFERENCES

1. M. Ehsani, Y. Gao, and J. M. Miller, "Hybrid electric vehicles: architecture and motor drives," Proc. IEEE. , vol. 95, no. 4, pp. 719-728, Apr. 2007.
2. D. Han, J. Noppakunkajorn, and B. Sarlioglu, "Comprehensive efficiency, weight, and volume comparison of SiC and Si-Based bidirectional DC-DC converters for hybrid electric vehicles," IEEE Trans. Veh. Technol., vol. 63, no. 7, pp. 3001–3010, Sept. 2014.
3. K. Jin, X. Ruan, M. Yang, and M. Xu, "A hybrid fuel cell power system,"IEEE Trans. Ind. Electron., vol. 56, no. 4, pp. 1212–1222, Apr. 2009.
4. M. A. Abusara, J. M. Guerrero, and S. M. Sharkh, "Lineinteractive UPS for microgrids," IEEE Trans. Ind. Electron., vol. 61, no. 3, pp. 1292, 1300, Mar. 2014.
5. X. Xiaoling, C. K. Tse, and R. Xinbo, "Bifurcation analysis of standalone photovoltaic-battery hybrid power system," IEEE Trans. Circuits Syst. I, Reg. Papers, vol.60, no.5, pp.1354-1365, May 2013.
6. H. L. Do, "Nonisolated bidirectional zero-voltage-switching dc–dc converter," IEEE Trans. Power Electron., vol. 26, no. 9, pp. 2563–2569, Sep. 2011.
7. P. Das, B. Laan, S. A. Mousavi, and G. Moschopoulos, "A nonisolated bidirectional ZVS-PWM active clamped DC–DC converter," IEEE Trans. Power Electron., vol. 24, no. 2, pp. 553-558, Feb. 2009.
8. L.Yang and T. Liang, "Analysis and implementation of a novel bidirectional DC – DC converter," IEEE Trans. Ind. Electron., vol. 59, no. 1, pp. 422- 434, Jan. 2012.
9. B. L. Narasimharaju, S. P. Dubey, and S. P. Singh, "Design and analysis of coupled inductor bidirectional dc-dc converter for high-voltage diversity," IET Power Electron., vol. 5, no. 7, pp. 998–1007, Aug. 2012.
10. M. R. Mohammadi, and H. Farzanehfard, "Analysis of diode reverse recovery effect on the improvement of soft-switching range in zero voltage-transition bidirectional converters," IEEE Trans. Ind. Electron., vol. 62, no. 3, pp. 1471 1479, Mar, 2015



INNO SPACE
SJIF Scientific Journal Impact Factor
Impact Factor: 7.282

doi crossref

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

निस्केयर
NISCAIR

International Journal of Advanced Research

in Electrical, Electronics and Instrumentation Engineering

9940 572 462 6381 907 438 ijareeie@gmail.com

Scan to save the contact details