International Journal of Scientific Research in Science, Engineering and Technology
Print ISSN: 2395-1990 | Online ISSN : 2394-4099 (www.ijsrset.com)
doi : https://doi.org/10.32628/IJSRSET

Implementation of A 3 Stage Dc-Dc Multiport Converter for Energy Storage System

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ARTICLEINFO

Article History:

Accepted: 01 April 2023
Published: 14 April 2023

Publication Issue
Volume 10, Issue 2
March-April-2023

Page Number
423-428

ABSTRACT

The DC-DC bidirectional converter has become a promising option for energy storage system and power related systems. The elaborate model of DC-Dc converter leads to shoot through and delay in output. With High concentration on the inductance to reduce the noise is proposed in this project. In this project, the state space averaging method is used to analyse the stability of the topology in boost and buck modes. The proposed structure is reliable because of no shoot-through concerns and high quality of output waveforms can be obtained due to the reduction in pulse width modulation (PWM) dead-time. The Li-battery is charged in constant current and constant voltage mode. A Charging system converts DC Voltage into Battery Storage.

Keywords : Converter, Lithium Battery, shoot through, Energy Storage.

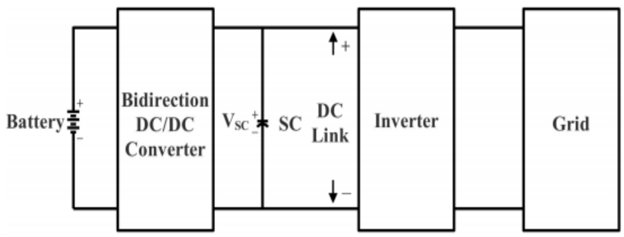
I. INTRODUCTION

Today as the usage or renewable energy source has increased due to the awareness of the effect of conventional energy sources on the environment. Especially, due to the massive usage of the fossil fuels. Now-a-days more and more researchers concentrate on exploring the renewable energy sources such as the Photovoltaic (PV) sources, the wind energy and so on. One of the most efficient and promising way to solve this problem is the use Photovoltaic (PV) solar energy. The PV systems connected to the grid are usually without energy storage systems. Massive penetration of PV systems with the capability of exporting electric power into the grid, but without energy storage systems, can affect the grid due to their intermit-tent nature. Therefore, integration of energy storage systems is essential to make the output power of PV systems dispatch able in supply and demand control. Therefore the need for producing an effective battery storage system arises. This project presents a control method for Full bridge high gain Resonant converters using PI mode controllers. Conventionally, the output voltage of a high gain converter is controlled by using a Fuzzy controller. In order to overcome these disadvantages, the PI control has been applied for the high gain converter. In this project, a control method for the high gain converter using PI control is proposed.

By varying the gain of the Gates through the PI control, not only can the dynamic characteristic of the high gain converter be improved. The main consideration carried in this project is the experimental and theoretical discussions concerning the effect of dc-bias currents on the magnetic flux saturation of the high-frequency transformer. The overall loss breakdown of the dc–dc converter compares the loss distribution of the low-voltage high-current converter with that of the high-voltage low- current converter to obtain good performance.

II. MULTIPORT CONVERTER

The single-phase, full-bridge bidirectional HIGH GAIN Converter was first introduced in for high-power density power conversion systems. The converter realizes a low component count and a low device stress. High power transfer capability in the converter can be achieved by simple phase-shift modulation . This converter is the most efficient when the dc-voltage ratio between the HVS and the LVS is close to the transformer turns ratio. In order to increase efficiency, soft- switching technology has been widely used in dc–dc converters. This project presents a new bidirectional, HIGH GAIN. The new converter is based on a dual half-bridge topology. Compared to the dual fullbridge topologies, it has half the component count for the same power rating With no total device rating (TDR) penalty. In addition, unified ZVS is achieved in either direction of power flow without any additional component. Therefore, a minimum number of devices is used in the proposed circuit. Also the design has less control and accessory power needs than its full- bridge competitors. All these new features allow efficient power conversion, easy control, lightweight and compacted packaging. The so-called “dc-blocking capacitors” are typically used to prevent the transformer from magnetic flux saturation. However, available high-frequency capacitors may not meet high-current requirements. Parallel connections of multiple capacitors are accompanied by bulkiness, increased cost, and decreased reliability

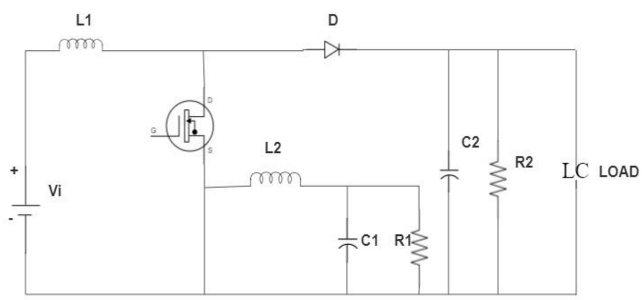


A. Block Diagram of Multiport Converter

The Block Diagram Consist of Following Components:

1. Battery
2. Dc-Dc Converter
3. Inverter
4. Pulse Generator

The block diagram of proposed system consists of PWM rectifier, filter, bidirectional converter and PWM generator then source is applied and using an ac input filter for reducing an harmonics, ripples and controlled rectifier is an purpose of convert the ac to dc source and again filter is used for reducing harmonics and ripples then bidirectional dc-dc converter has both side power flow and conversion process is done PWM generator generate the pulse. Driver unit is used to drive the controlled rectifier and bidirectional isolated DC-DC converter and here load is dc drive. And bidirectional dc-dc converter as two direction of power flow one is high voltage side to low voltage side(sourceside to load side)and another one is low voltage to high voltage side(load side to source side).



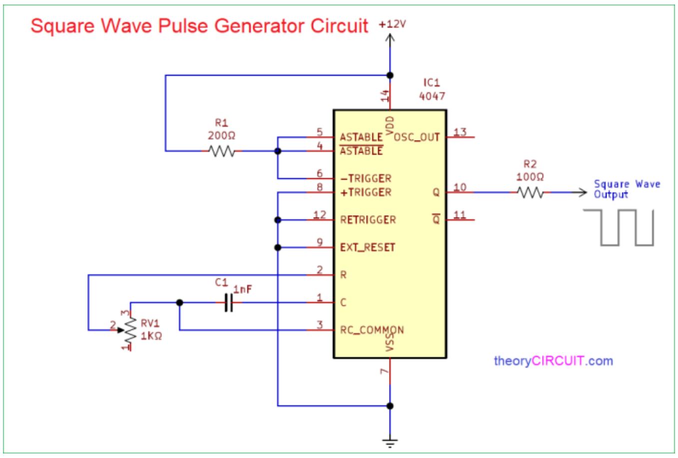
B. Circuit Diagram of Dc-Dc Multiport Converter

Components Used In Circuit Diagram

1. Single switch relay
2. Transformer
3. Battery
4. PIC Controller
5. LED Display
6. Keypad Matrix
7. Buck and Boost Converter
8. Multi-meter
9. MOSFET Switches
10. Capacitor
11. Inductor
12. Diode

Working

A battery of 10 volt supply is passed to relay. Here the relay is controlled by a PIC Controller. Once the reset button is switched, we can change the modes. Buck and Boost modes are changed according to the needed conversion. By using multi-meter we can see the output of the conversion in a display matrix. For Example: if 10 volt input is given in buck conversion then the output will be less than 10 volt.



C. Square Wave Pulse Generator

The Pulse generator used to switch On and Off the switches (MOSFET). In hardware device it is connected with a PIC Microcontroller. Whereas in simulation it is directly controlled by a pulse generator.

D. Battery

In the buck-boost battery charge controller utilizes four switching FETs, along with a battery FET, in order to charge a battery that is either below or above the input voltage. It achievesthis by seamlessly switching between buck and boost modes ofoperation, depending on theinput and output voltage levels.

E. Inverter

In the buck converter takes a positive input voltage and converts it to a positive output voltage of smaller magnitude.

III. DESIGN CALCULATION FOR DC-DC MULTIPORT CONVERTER

Beginning with the buck converter, it is a switch mode DC to DC electronic converter in which the output voltage will be converted to a level less than the input voltage. By the law of conservation of energy, the input power has always to be equal to output power assuming that there are no losses in the circuit.

$$Input\ power, P_{in} = Output\ power, P_{out}$$

Since the input voltage is always greater than the output voltage of a buck converter, the output current will always be greater than the input current.

$$Input\ Voltage, V_{in} > Output\ Voltage, V_{out}$$

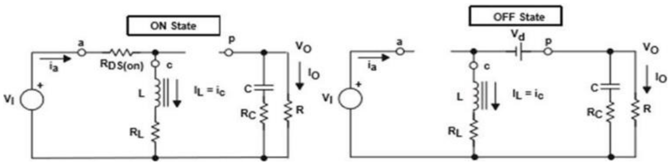
$$Input\ Current, I_{in} < Output\ Current, I_{out}$$

Anotherdifference of the buck converter and boost converter is their principle of operation. In buck converter, theinductor stores energy if the switch is on, and in the boost converter the inductor stores energy if the switch is off.

$$Input\ Voltage, V_{in} < Output\ Voltage, V_{out}$$

$$Input\ Current, I_{in} > Output\ Current, I_{out}$$

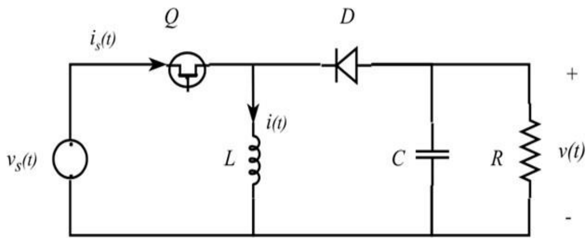
The buck-boost converter is a combination of the buck converter and a boost converter, and that is the output voltage can either be higher or lower than the input voltage just like a buck converter and aboost converter.



The duration of the On State is

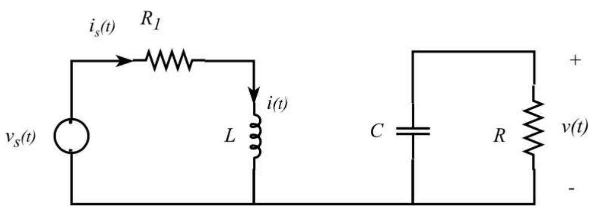
$$D \times T_S = T_{On}$$

where D is the duty cycle (set by the control circuit) expressed as a ratio of the switch on time to the timeof one complete cycle (T_S).



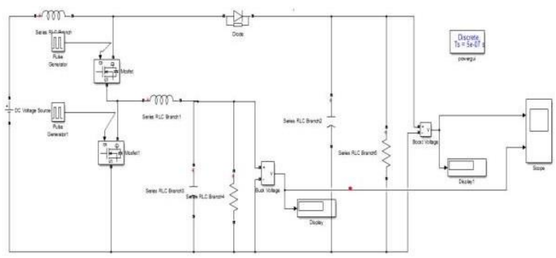
Buck Boost Converter

Boost Converter



IV. SIMULATION OF MULTIPORT CONVERTER

The proposed system explains the ac source is applied to the circuit source impedance provide the input current and voltage and filter is used to reduce harmonics and ripples then the PWM rectifier converts ac to dc then bidirectional converter has the both side process that is from source side to load side (high voltage side to low voltage side) using inverter to convert dc to ac in middle of the circuit step down transformer is used and again rectifier is used to convert ac to dc. Then another side from load side to source side (low voltage to high voltage side) using rectifier to convert ac to dc and in middle of the circuit step up transformer is used and again inverter is used to convert dc to ac source and finally energy is stored lithium ion battery.

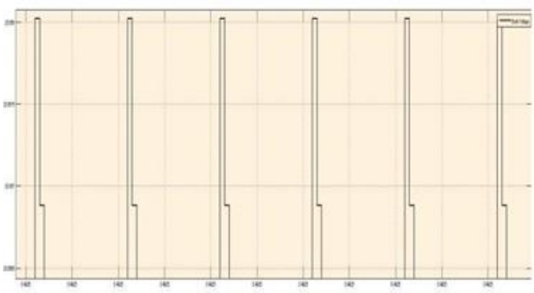


Simulation for implementation of 3 stage dc-dc multiportconverter for energy storage system

Lithium is a storage device for charging and discharging, efficiency is measured here using an isolation transformer and it is an high frequency transformer it has both low voltage side and high voltage side. In the primary side four switches are connected two switches are MOSFET and two switches are capacitor then in secondary side four switchesare connected two switches are IGBT and another two switches.

SIMULATION OUTPUT

Boost Voltage



Buck Voltage

V. CONCLUSION

Compared to the dual full-bridge topologies, it has half the component count for the same power rating with no total device rating (TDR) penalty. The multiport converter has less number of passive components as compared to the conventional dc-dc buck converter structure and has no shoot-through concerns with improved quality of output waveforms due to the reduction of dead-time. Detailed theoretical analysis, simulations and experiments are performed and it has been revealed that discontinuous PWM scheme can improve the dc-link voltage utilization in CF mode of operation and hence reduce the switching losses. In addition, unified ZVS is achieved in either direction of power flow without any additional component. Therefore, a minimum number of devices is used in the proposed circuit. Also the design has less control and accessory power needs than its full-bridge competitors. All these new features allow efficient power conversion, easy control, light weight and compacted packaging. The "dc-blocking capacitors "are typically used to prevent the transformer from magnetic flux saturation. However, available high-frequency capacitors may not be the high-current requirements. Parallel connections of multiple capacitors are accompanied by bulkiness, increased cost, and decreased reliability. The multiport converter is a good alternative to the full-bridge isolated bidirectional dc–dc converter in high power applications and has distinct advantages for high power density and low cost applications. As a result of incorporating the resonant operation mode into the traditional high boost ratio PWM converter, the turn off loss of the switch is reduced, increasing the efficiency of the converter under all load conditions.

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Cite this article as :

Dr. P. Jamuna, K. Sindhuja, E. Priyenga, S.K. Thanyasri, C. Nandhini, "Implementation of A 3 Stage Dc-Dc Multiport Converter for Energy Storage System", International Journal of Scientific Research in Science, Engineering and Technology (IJSRSET), Online ISSN : 2394-4099, Print ISSN : 2395-1990, Volume 10 Issue 2, pp. 423-428, March-April 2023.
Journal URL : https://ijsrset.com/IJSRSET2310269