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Design and Control of Soft Switching Bidirectional DC-DC High Gain Converter

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ABSTRACT: In this project, a soft-switching bidirectional dc-dc converter using a lossless active snubber has been proposed. In the proposed converter, ZVS of the main switches and ZCS of the auxiliary switches are always achieved. In addition to this we are utilizing the active snubber, there is no reverse-recovery problem of the intrinsic body diodes of the switches. Since the active snubber operates in a short time, the increased conduction loss of the proposed converter is relatively lower than the soft-switching bidirectional converter. Thus, the overall efficiency improvement is achieved over a wide range of load. At the same time by adjusting according to loads, it is possible to achieve optimized overall efficiency throughout the whole loading range. In the present work, the DC motor has been used to speed control by the duty cycle of the switches. A unified controller has been designed and simulated for the control of the both the modes i.e. motoring as well as scope of simulation in Matlab.

KEYWORDS: dc motor, snubber, dc-dc converter, buck converter, boost converter

I. INTRODUCTION

In recent years, alternative energy systems and applications like eco-friendly cars have been focused on due to the exhaustion of fossil fuel and severe environmental pollution. Bidirectional dc-dc converters are one of the most important energy conversion systems in the applications such as plug-in hybrid electric vehicle (PHEV), fuel-cell vehicle, renewable energy system, and uninterruptible power supply (UPS). In PHEV system, the bidirectional dc-dc converter acts as an energy transfer system from a low voltage battery to a DC-link that is an input voltage of an inverter for operating a vehicle motor, or from a DC-link to a battery for charging regenerative energy. In the renewable energy systems, including fuel cell systems, photovoltaic systems, and wind power systems, the bidirectional dc-dc converter is essential for electric power conversion between a low voltage battery where dump power is charged and a high voltage source for home appliances. The bidirectional dc-dc converter is divided into an isolated type and a non-isolated type. On the other hand, the non-isolated bidirectional dc-dc converter has high efficiency due to simple structure. Recently, soft-switching techniques are applied to the non-isolated bidirectional dc-dc converter to achieve soft-switching of power switches in a wide range of load and reduce switching noises.

II. PROPOSED SYSTEM

A soft-switching bidirectional dc-dc converter using a lossless active snubber is proposed in this paper. In the proposed converter, zero-voltage-switching (ZVS) of main switches is achieved by utilizing an active snubber which consists of auxiliary switches, diodes, an inductor, and a capacitor. Although conduction losses associated with additional components increase, switching losses are significantly reduced due to the ZVS operation of main switches. Therefore, total efficiency is improved. Moreover, there is no reverse-recovery problem of the intrinsic body diodes of the switches. To verify the ZVS of the main switches and efficiency improvement of the proposed bidirectional dc-dc converter, theoretical analysis and experimental results from a 200 W prototype are discussed. In the proposed DC

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motor has been speed controlled by the duty cycle of the switches .A unified controller has been designed and simulated for the control of the both the modes.

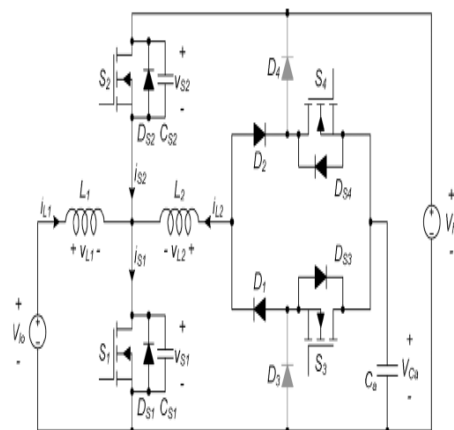


Fig:1 circuit diagram of proposed system

III. CONVERTERS

A **boost converter (step-up converter)** is a power converter with an output DC voltage greater than its input DC voltage. It is a class of switching-mode power supply (SMPS) containing at least two semiconductor switches (a diode and a transistor) and at least one energy storage element. Filters made of capacitors (sometimes in combination with inductors) are normally added to the output of the converter to reduce output voltage ripple.

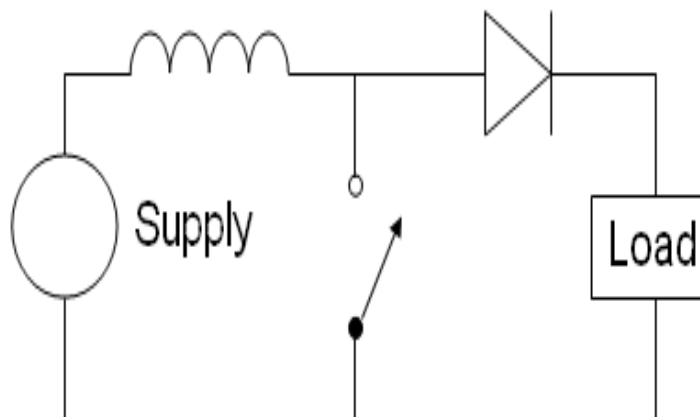


Fig:2 boost converter diagram

A. OPERATING PRINCIPLE

The key principle that drives the boost converter is the tendency of an inductor to resist changes in current. When being charged it acts as a load and absorbs energy (somewhat like a resistor), when being discharged, it acts as an energy

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source (somewhat like a battery). The voltage it produces during the discharge phase is related to the rate of change of current, and not to the original charging voltage, thus allowing different input and output voltages.

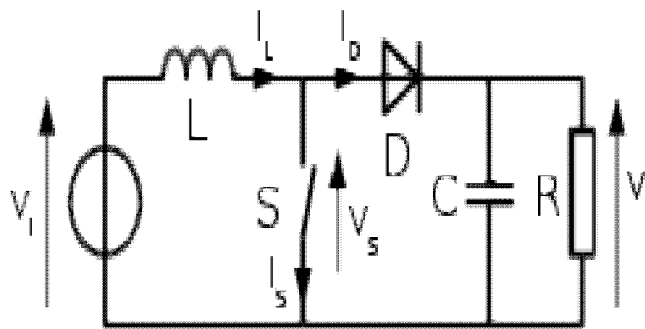


Fig. 3: Boost converter Diagram

IV. PULSE-WIDTH MODULATION (PWM)

Pulse-width modulation (PWM), or **pulse-duration modulation (PDM)**, is a commonly used technique for controlling power to inertial electrical devices, made practical by modern electronic power switches.

The average value of voltage (and current) fed to the load is controlled by turning the switch between supply and load on and off at a fast pace. The longer the switch is on compared to the off periods, the higher the power supplied to the load is.

The PWM switching frequency has to be much faster than what would affect the load, which is to say the device that uses the power. Typically switchings have to be done several times a minute in an electric stove, 120 Hz in a lamp dimmer, from few kilohertz (kHz) to tens of kHz for a motor drive and well into the tens or hundreds of kHz in audio amplifiers and computer power supplies.

The term *duty_cycle* describes the proportion of 'on' time to the regular interval or 'period' of time; a low duty cycle corresponds to low power, because the power is off for most of the time. Duty cycle is expressed in percent, 100% being fully on.

The main advantage of PWM is that power loss in the switching devices is very low. When a switch is off there is practically no current, and when it is on, there is almost no voltage drop across the switch. Power loss, being the product of voltage and current, is thus in both cases close to zero. PWM also works well with digital controls, which, because of their on/off nature, can easily set the needed duty cycle.

PWM has also been used in certain communication systems where its duty cycle has been used to convey information over a communications channel.

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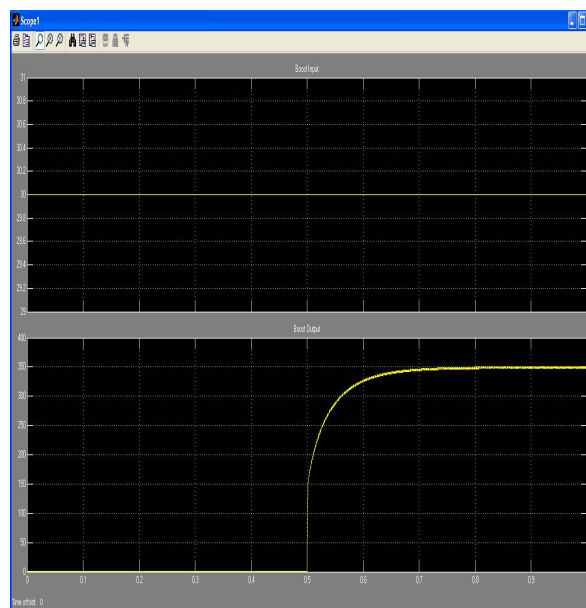
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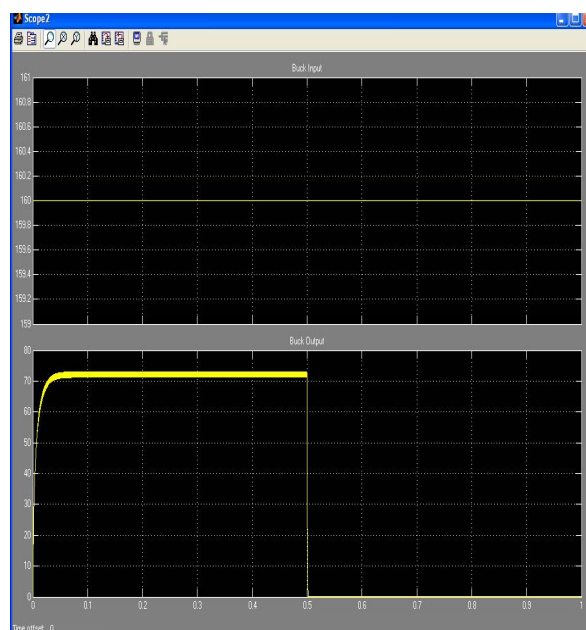
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V. SIMULATION RESULT

BOOST INPUT AND OUTPUT:



BUCK INPUT AND OUTPUT



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VI. CONCLUSION

In this project, a soft-switching bidirectional dc-dc converter using a lossless active snubber has been proposed. In the proposed converter, ZVS of the main switches and ZCS of the auxiliary switches are always achieved. In addition, by utilizing the active snubber, there is no reverse-recovery problem of the intrinsic body diodes of the switches. Since the active snubber operates in a short time, the increased conduction loss of the proposed converter is relatively lower than the soft-switching bidirectional converter. Thus, the overall efficiency improvement is achieved over a wide range of load. Moreover, by adjusting according to loads, it is possible to achieve optimized overall efficiency throughout the whole loading range.

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