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# Improved Dc to Dc Converter with Single Input Multiple Output

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**ABSTRACT**

**In this paper modified single input multiple output dc-dc converters can be used to give a multi outputs. It has three outputs. That is low voltage power source is converted into high-voltage dc bus and middle voltage output terminals. It is coupled inductor based dc-dc converter. It has only one power switch with the properties of voltage clamping and soft switching. As a result, different level of output voltages, and multiple outputs, high efficiency power conversion and high step up ratio.The aim of this paper is to design a SIMO (Single Input Multiple Output) converter and compare it with other converter topologies. The D.C output voltage which can be obtained from renewable energy systems like fuel cell, solar cell etc. is very low and they need to be boosted to be used in various applications. The converter discussed can boost the low voltage input and give multiple outputs. As multiple outputs are obtained in this converter, it can be used to power amultilevel inverter which needs more than one input source.**

**Keywords: MOSFET, COUPLED INDUCTOR, VSI, PWM, ZCS, HVSC.**

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## I. INTRODUCTION

This converter is a newly designed single input multiple output dc-dc converters with coupled inductor. The proposed converter uses only one power switch and main objective of high-efficiency power conversion, and different outputs, high step up ratio. The techniques of soft switching and voltage clamping are used to reduce the switching loss and conduction loss. a dc-dc converter is an electronic circuit which is used to convert a source of direct current (dc) from one voltage level to another voltage level. The boost Converter is a single input Single output device. To obtain multiple outputs, number of switches will be increases. This in turn increases the switching loss and stress. And that efficiency is low. The existing system is single-input single-output dc-dc converter with different voltage gains are combined to satisfy the requirement of different voltage levels, so this system control is complicated and cost is high. The existing system of the single input multi output dc-dc converter has a more then three switches for one output were required. In this method only suitable for low voltage and low power applications. The existing system of the dc – dc converter is generating buck, boost and inverter output simultaneously. However, over three switches for one output required. It is suitable for low voltage and low power applications. The proposed systems are increasing the conversion efficiency and reduce the manufacturing cost, voltage gain, and control complexity. The middle capacitor voltage is depends on auxiliary inductor. The output of the high-voltage dc bus can be controlled by a PI control.

Single Input Multiple Output (SIMO) converters are widely used in industrial applications. Converters having single input source and generating more than one isolated or non-isolated output voltage are called Single Input Multiple Output (SIMO) converters. Small size and high efficiency are attractive features of any converter. In order to have small size for the converter, the switching frequency must be high. Switching at higher frequencies reduces the size of the isolating transformer of the converter and also reduces the sizes of output inductor and capacitor, thereby bringing down the volumetric power density of the converter. One of the factors which prevent switching at higher frequencies is the switching loss of the power devices. As the switching frequency increase, more switching transitions occur in a given interval of time which results in switching losses. To solve this issue, soft switching techniques, either ZCS (Zero Current Switching) or ZVS (Zero Voltage Switching) must be used. Some of the applications require multiple stepped up outputs. In recent years, several methods and topologies have been proposed to design single input multiple output converters.

**Single Input Multiple Output DC to DC Converter:**

Fig. 1 shows the block diagram of single input multi output dc-dc converter. In this, the dc voltage from the source is fed into dc-dc converter, it could boost the input voltage and the boosted voltage is connected to various loads. This converter has a multiple output voltages. That is low voltage and middle voltage and high voltage output terminals. This converter is controlled by a PWM controller.

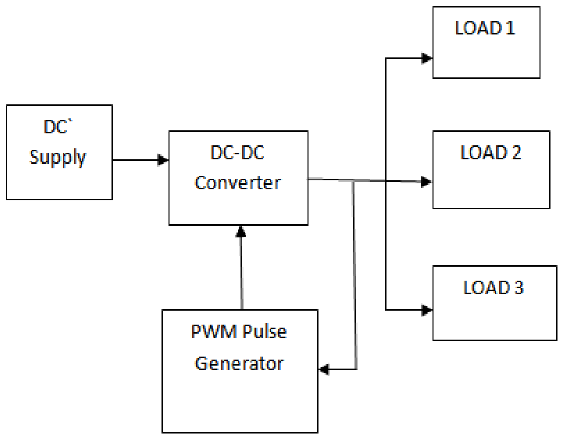



Fig 1:Block Diagram of SIMO

## II. CIRCUIT DIAGRAM

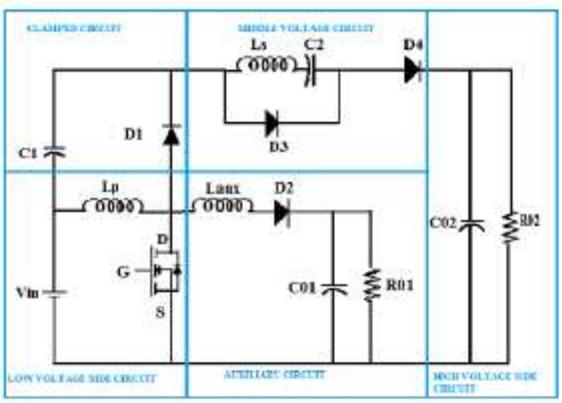



Fig. 2:SIMO Converter

This section describes a SIMO converter with a coupled inductor. The converter uses only one power switch to achieve the objectives of high efficiency, high voltage gain, different output levels and voltage clamping property. But as can be seen the two outputs have common ground, which makes this topology unsuitable for powering multi-level inverters. The design of this converter can be modified to make the outputs isolated, but at the same time the advantages of high efficiency, high voltage gain and voltage clamping property can be maintained. The fuzzy logic controller is used in controlling both the converters in fig. 1. The fig. 1 shows the topology of SIMO converter to obtain two different voltage levels from a single input power source. The converter has five parts viz. 1) Low voltage Side Circuit (LVSC) 2) Clamped Circuit 3) Middle Voltage Circuit 4) Auxiliary circuit.

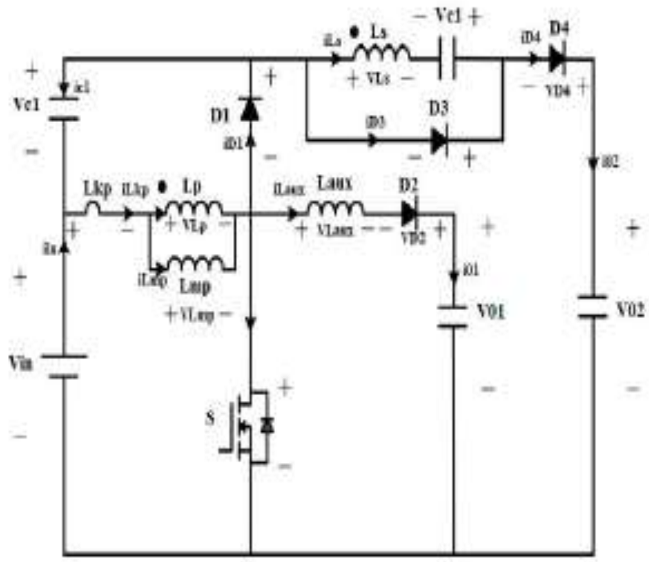



Fig 3: Voltage polarities and Current Direction of SIMO Converter

In fig. 3, voltage polarities and current directions are marked. In this converter, techniques of soft switching and voltage clamping are utilized to reduce switching and conduction losses. The current transition time (rate of change of current) in the primary winding of the coupled inductor enables the power switch to turn on with zero current switching. Similarly the presence of auxiliary inductor (Laux) enables switching of diode D1 at ZCS condition. The secondary winding (Ls) of coupled inductor has more turns than primary winding (LP) of the coupled inductor. This is because it is essential to have longer discharge cycle in the secondary side of the coupled inductor for the proper operation of the converter. The output voltage of the auxiliary side circuit can be adjusted by proper design of auxiliary inductor (Laux).The output of High Voltage Side Circuit (HVSC) can be controlled by a simple PI controller or Fuzzy logic Controller. The coupled inductor can be modeled as an ideal transformer including magnetizing inductor (Lmp) and leakage inductor (LKP).

The turn's ratio (N) can be defined as

$$N=Ns/NP \qquad \text{.........(1)}$$

The coupling coefficient is defined as

$$k=Lmp/(Lkp+Lmp) = Lmp/Lp \qquad \text{........(2)}$$

The voltage gain of the converter is less sensitive to the coupling coefficient (k) and clamped capacitor C1.Thus

C1can be selected to completely absorb leakage inductor energy. The coupling coefficient (k=1) is set to one to obtain Lmp=Lp.

## III. MODES OF OPERATION

Following are the modes of operation:

**Mode1:**

In this mode main switch is turned for a span of time. The positive polarity of the primary and secondary windings of the coupled inductor is marked in dots. As can be seen, the polarity of the secondary winding is such that diode D3 is forward biased and is conducting. The secondary current charges the middle voltage capacitor C2.When the auxiliary inductor completely releases its stored energy, diode D2 turns off.

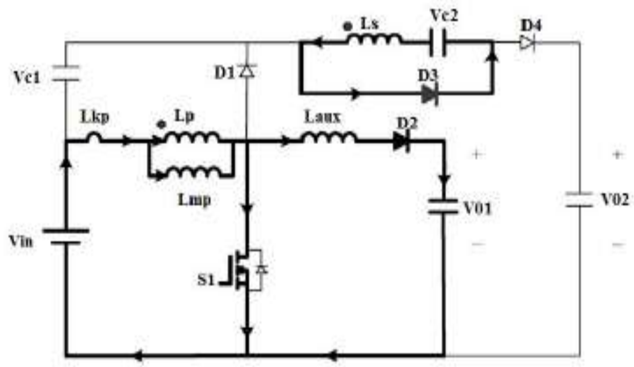



Fig:4 Mode 1

**Mode 2:**

The auxiliary inductor discharges its charge completely and diode D2 turns off. The secondary side of the coupled inductor is still discharging.

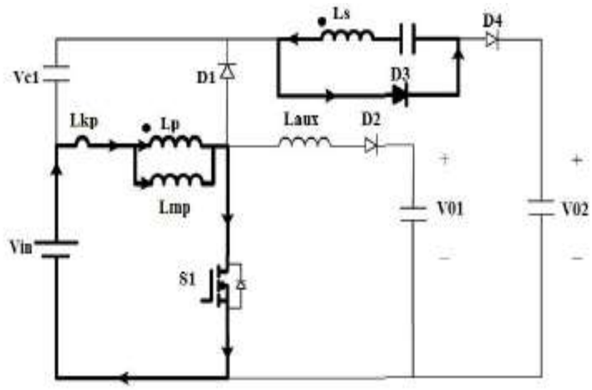



Fig 5:Mode 2

**Mode 3:**

Main switch is turned off. When main switch is turned off, the polarity of the primary side of the coupled inductor changes and hence diode D1 turns ON. The primary current charges the clamping capacitor and also provides energy to the auxiliary inductor and diode D2 conducts, providing supply to the output load. During this mode, the secondary winding is still discharging its energy to capacitor C2, as it is designed with greater inductance for longer discharge cycle.

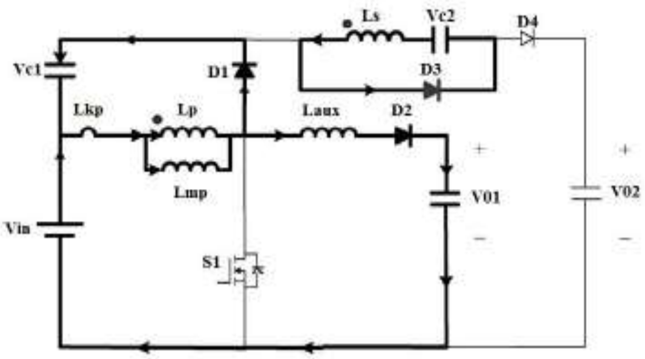



Fig 6: Mode 3

**MODE 4:**

Switch is turned off persistently. The secondary current is induced in the reverse direction from the energy of the magnetizing inductor Lamp and flows through diode D4 to the High Voltage Side Circuit (HVSC).The partial energy of primary side is given to auxiliary inductor, thus auxiliary side output also receives supply.

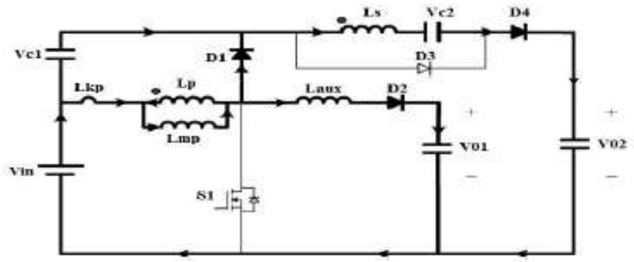



Fig 7:Mode 4

**MODE 5:**

When primary current of inductor becomes equal to auxiliary inductor current, diode D1 turns off. D1 should be selected as a low voltage schottky diode so that it cuts off without a reverse recovery current. The input power source, clamped capacitor, secondary winding, middle voltage capacitor comes in series to provide power to the load at the HVSC circuit through diode D4.

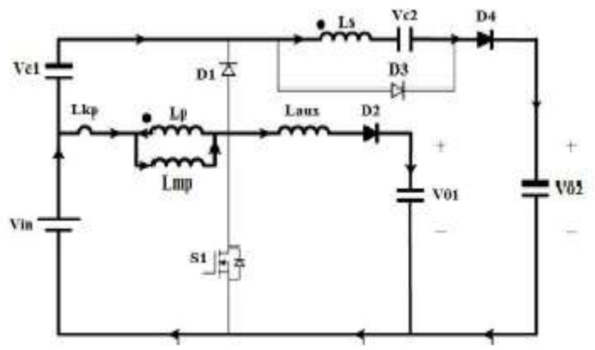



Fig 8:Mode 5

**MODE 6:**

Switch is turned on again. The auxiliary inductor current needs time to decay to zero, diode D2 keeps conducting. The input source, clamped capacitor, secondary winding, middle voltage capacitor connects in series to power load at HVSC. The rate of rise in current through primary winding limits current rush to switch and thus switch turns at ZCS condition. When secondary current decays to zero this mode ends. After that, the next cycle begins and repeats the operation in mode 1.

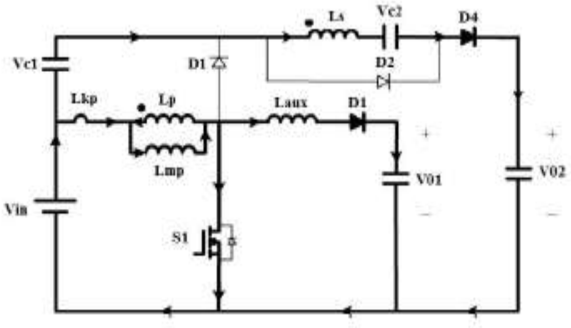
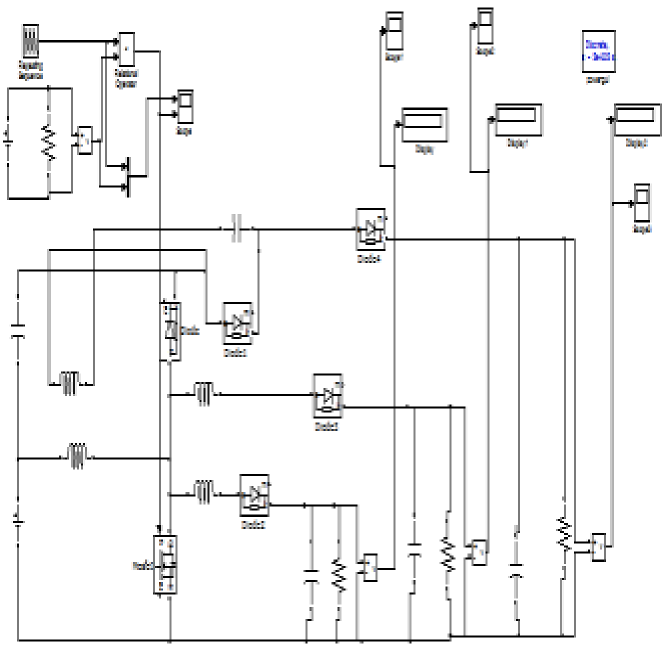



Fig 9:Mode 6

## IV. SIMULATION

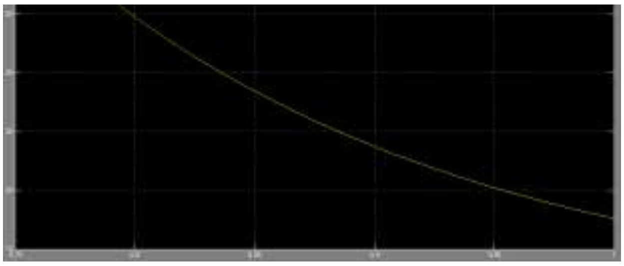
The simulation of modified single input multi output dc-dc converter is done using MATLAB/SIMULINK software and the results are as follows. The simulation results are discussed and compared with the output voltage results. single input multi output dc-dc converter is simulated by using pulse width modulation technique.PWM technique is connected with input of the MOSFET gate terminal.



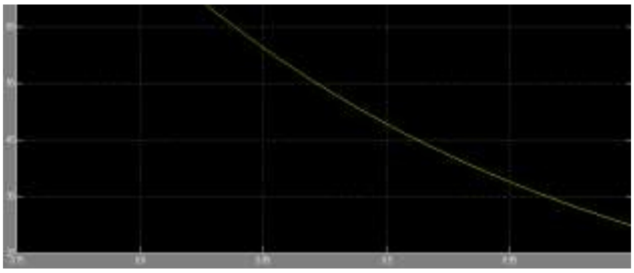
Modified Single Input Multi Output DC-DC Converter can boost the voltage low voltage input source .That input voltage is 12V to controllable Boost the voltage is 14V,and High voltage is 200V, and middle output-voltage is 20-24V.The auxiliary inductor value is 2µH. And that capacitor value is c1=85µf, c2 value is 10µf.One coupled inductor is used. The primary of the coupled inductor is 2µH.secondary of the coupled inductor is 75µH.

**Simulation results:**

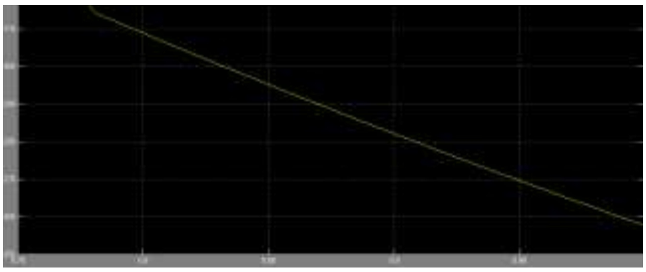
**Output1:**



**Output2:**



**Output3:**



**PWM SWITCHING TECHNIQUE**

Modified single input multi output dc-dc converter is simulated by using pulse width modulation technique. The reference signal and carrier waves are compared. The pulse is generated at reference wave is greater than the carrier wave. The pulse width modulation technique is connected with input of the MOSFET gate terminal. The pulse width is based on duty cycle.

**SOFT SWITCHING TECHNIQUES**

There are two types of switching techniques,
1] Zero voltage switching
2] Zero current switching.

ZERO VOLTAGE SWITCHING
Specifically means zero-voltage turn-on, the voltage across the device current increase is reduced to zero before the current increases

ZERO CURRENT SWITCHING

Specifically means zero-current turn-off, the current flowing the through the device is reduced to zero before the voltage increases.

## V. CONCLUSION

This paper has presented a SIMO dc–dc converter and this coupled inductor based converter was applied well to a single input power source plus three output terminals composed of two boost and one inverted voltages. The proposed SIMO converter is suitable for the application required one common ground, which is preferred in most applications. As mentioned above the voltage gain can be substantially increased by using a coupled inductor, the stray energy can be recycled by a clamped capacitor into the output terminal 1 or output terminal 2 to ensure the property of voltage clamping and an auxiliary inductor is designed for providing the charge power to the load 1 and assisting the switch turned ON under the condition of ZCS. Thus the proposed SIMO converter provides designers with an alternative choice for converting a low voltage source to multiple boost outputs with inverted voltage output efficiently.

## LIMITATIONS AND FUTURE SCOPE

The efficiency of proposed converter decreases when the number of outputs increases beyond three. It is worthy to investigate the proposed converter's efficiency of power conversion when used to power multi-level inverter requiring more than two sources.

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