

# **A High Step-Up DC-DC Converter Using PV System Based on Integrating Coupled Inductor with Closed Loop Control Strategy**

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**ABSTRACT:** High-efficiency Step-Up Converter by using PV system with closed loop control is proposed in this paper. Through employ of coupled inductor and switched capacitor, the proposed converters attain high step-up conversion ratio without operating at extreme duty ratio. Due to reutilize of leakage energy, the efficiency is developed and the large voltage spike on switch is improved, these kinds a Medium voltage-rated IGBT can be implemented for decreases of conduction losses. This proposed converter is controlled by pi control system. The operation principle and steady state analyses are presented along with the comparison of the output voltage for open loop and closed loop control strategies. Simulation results are presented to demonstrate the effectiveness of the converter.

**KEYWORDS:** Pv Model, Coupled inductor, Switched Capacitor, high step-up converter, PI controller

## **I. INTRODUCTION**

In many industry applications such as uninterrupted power supplies (UPS), electric traction, distributed photovoltaic (PV) generation systems, fuel cell energy conversion systems, automobile HID headlamps, and in some medical equipment, a high voltage gain DC-DC boost converters play a major role. However, output voltages of the PV cells, fuel cells and wind power are not large enough for connecting to ac utility voltage. Series connected PV panels can provide a large DC voltage but it is difficult to avoid the shadow effect in the PV panels. High step up converters are suitable solutions for the aforementioned problem. Each PV panel can be connected to particular high step up converter. These converters boost the low input voltages (24-40V) to a high voltage level (300-400V). The main features of high step up converters are their large conversion ratio, high efficiency and small size.

This paper presents a high step up dc-dc converter for pv system. The proposed circuit consist of a coupled inductor and two voltage multiplier cells in order to obtain high voltage step up .In addition a capacitor is charged using the energy stored in the coupled inductor, which increases the voltage transfer gain. The energy used in the leakage inductance is recycled with the use of active clamp circuit. In this proposed topology the voltage stress across the switch is reduced. Therefore a main power switch with low resistance RDC(on) can be used to reduce the conduction losses. Comparison of the proposed converter with open loop and closed loop control is presented. The closed loop control is achieved by using Proportional Integral (PI) controller.

## **II. LITERATURE SURVEY**

These converters boost the low-input voltages (24–40 V) to a high-voltage level (300–400 V). The main features of high step-up converters are their large conversion ratio, high efficiency, and small size. conventional boost converters can achieve high-voltage gain with an extremely high duty ratio. However, the performance of the system will be deteriorated with a high duty cycle due to several problems such as low conversion efficiency, reverse-recovery, and electromagnetic interference problems. Some transformer-based converters like forward, push–pull, or flyback

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converters can achieve high step-up voltage gain by adjusting the turn ratio of the transformer. However, the leakage inductor of the transformer will cause serious problems such as voltage spike on the main switch and high power dissipation. In order to improve the conversion efficiency and obtain high step-up voltage gain, many converter structures have been presented. Switched capacitor and voltage lift techniques have been used widely to achieve high step-up voltage gain. However, in these structures, high charging currents will flow through the main switch and increase the conduction losses. Coupled-inductor-based converters can also achieve high step-up voltage gain by adjusting the turn ratios. However, the energy stored in the leakage inductor causes a voltage spike on the main switch and deteriorates the conversion efficiency. To overcome this problem, coupled-inductor-based converters with an active-clamp circuit have been presented in. Some high step-up converters with two-switch and single-switch are introduced. However, the conversion ratio is not large enough. As a solution for the above mentioned problems this paper presents a new topology.

## 2.1 Proposed High Step Up converter

This paper presents a novel high step-up dc/dc converter for renewable energy applications. The suggested structure consists of a coupled inductor and two voltage multiplier cells in order to obtain high-step-up voltage gain. In addition, a capacitor is charged during the switch-off period using the energy stored in the coupled inductor, which increases the voltage transfer gain. The energy stored in the leakage inductance is recycled with the use of a passive clamp circuit. The voltage stress on the main power switch is also reduced in the proposed topology. Therefore, a main power switch with low resistance RDS(ON) can be used to reduce the conduction losses. The operation principle and the steady-state analyses are discussed thoroughly.

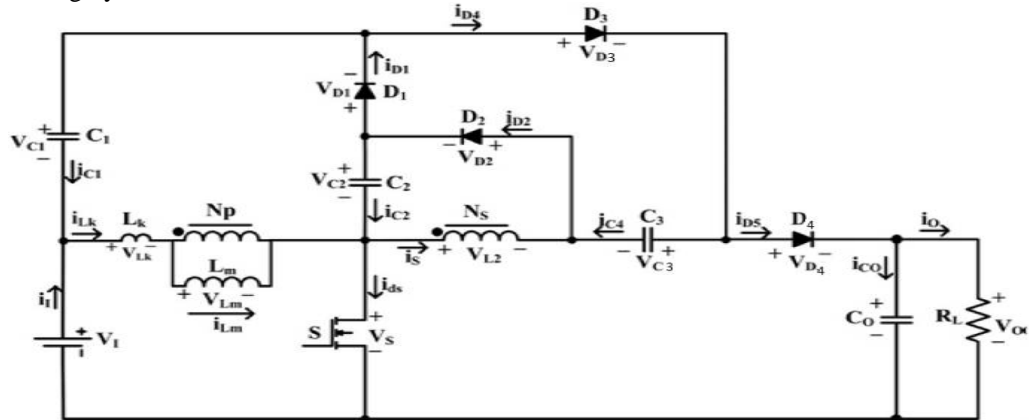


Fig 2.1 Circuit configuration of high-step- up converter

## III. PHOTOVOLTAIC MODULE

Modelling is the basis for computer simulation of a real system. It is usually based on a theoretical analysis of the various physical processes occurring in the system and of all factors influencing these processes. Mathematical models describing the system characteristics are formulated and translated into computer codes to be used in the simulation process. Photovoltaic cell models have long been a source for the description of photovoltaic cell behaviour for researchers and professionals. The most common model used to predict energy production in photovoltaic cell modelling is the single diode circuit model that represents the electrical behaviour of the pn-junction is given in 3.1 Figure shows how photovoltaic system works. The ideal photovoltaic module consists of a single diode.

A solar cell is the building block of a solar panel. A photovoltaic module is formed by connecting many solar cells in series and parallel. Considering only a single solar cell; it can be modelled by utilizing a current source, a diode and two resistors. This model is known as a single diode model of solar cell

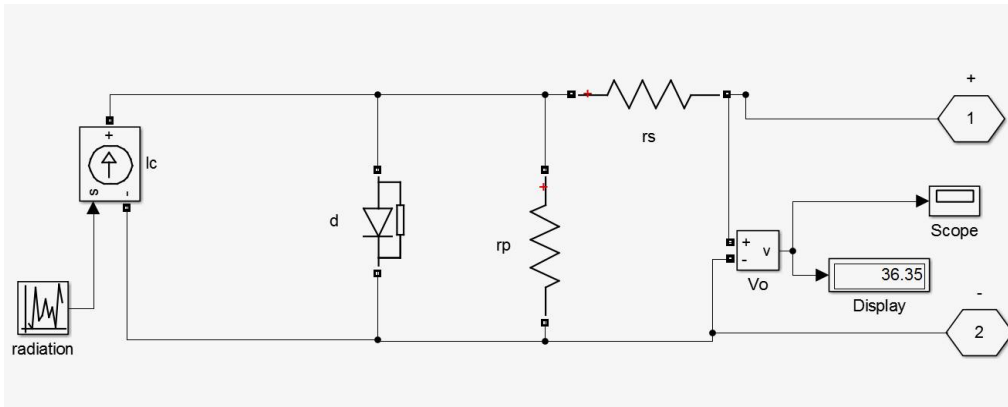


Figure 3.1: Single diode model of a solar cell

#### IV. OPERATING PRINCIPLE OF THE PROPOSED CONVERTER

The switch is turned ON, the supply voltage magnetises the leakage inductance and mutual inductance. Thus the current through the leakage inductance and mutual inductance of the coupled inductor increases linearly and at the secondary side the current decreases. During this time interval diodes D1, D2, and D4 are conducting and diode D3 conducting for a small time period. The capacitor C3 is charged by dc source V1, clamp capacitor and the secondary side of the coupled inductor. The clamp capacitor C1 is charged by the stored energy in capacitor C2 and the energies of leakage inductor Lk and magnetising inductance Lm. This interval ends when  $i_{Lk}$  is equal to  $i_{Lm}$ . When the switch is turned OFF, the clamp capacitor C1 is charged by the capacitor C2 and the energies of leakage inductance Lk and magnetising inductance Lm. The current through the leakage inductance and magnetising inductance are decreasing. Also, a part of the energy stored in Lm is transferred to the secondary side of the coupled inductor and which charges the capacitor C2 through diode D2. In this interval the dc input voltage V1 and stored energy in the capacitor C3 and inductance of both sides of the coupled inductor charge the output capacitor CO and provides the demand energy of the load RL.

##### 4.1 CONTROL STRATEGY

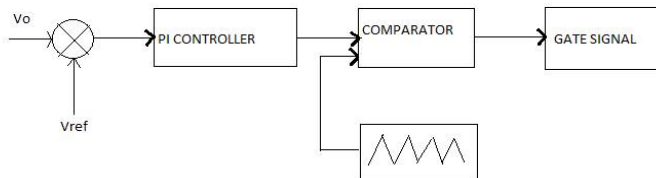
In order to achieve good voltage regulation closed loop control methods are introduced. In pulse width modulation (PWM) control, the duty ratio is linearly modulated in a direction that reduces the error. When the input voltage is perturbed, that must be sensed as an output voltage change and error produced in the output voltage is used to change the duty ratio to keep the output voltage to the reference value. The control circuit is shown in Fig.3

Due to its simpler layout they are easier to construct. Since these systems do not have a feedback mechanism, they are very inaccurate in terms of result output and hence they are unreliable too. Due to the absence of a feedback mechanism, they are unable to remove the disturbances occurring from external sources. Closed loop control schemes are more accurate than open loop system due to their complex construction. They are equally accurate and are not disturbed in the presence of non-linearities. Since they are composed of a feedback mechanism, so they clear out the errors between input and output signals, and hence remain unaffected to the external noise sources. The closed loop PI controller is used in the proposed converter to achieve the desired output voltage. The PI controller continuously calculates an error value as the difference between a measured process variable and a desired set point. The controller attempts to minimize error over time by adjustment of a control variable. PI controllers are fairly common, since derivative action is sensitive to measurement noise. PI controller is implemented here due to its several advantages. Steady state error resulting from P controller is easily overcome by the use of PI controller

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## V.SIMULATION RESULTS

This topic will show the waveforms obtained by simulation in MATLAB 2014a software, using the library of the physical model of the photovoltaic panel. specifications of the implemented model are show in table 1

PARAMETER	VALUE
Input dc voltage	40 V
Output voltage	400 V
Switching frequency	60kHz
Coupled inductor	Lk=1uH,Lm=300 uH
Capacitors C1,C2,C3,C0	47,47,100,220 uH

The Figure 5.1 shows the circuit simulated.

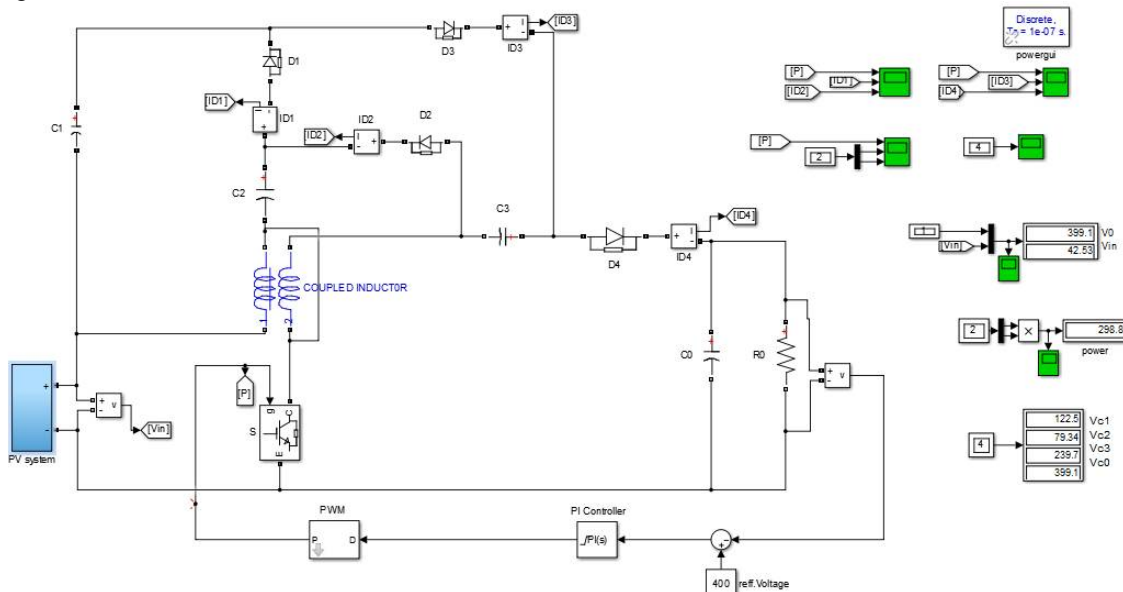


Fig 5.1 Proposed closed loop Converter with PV module

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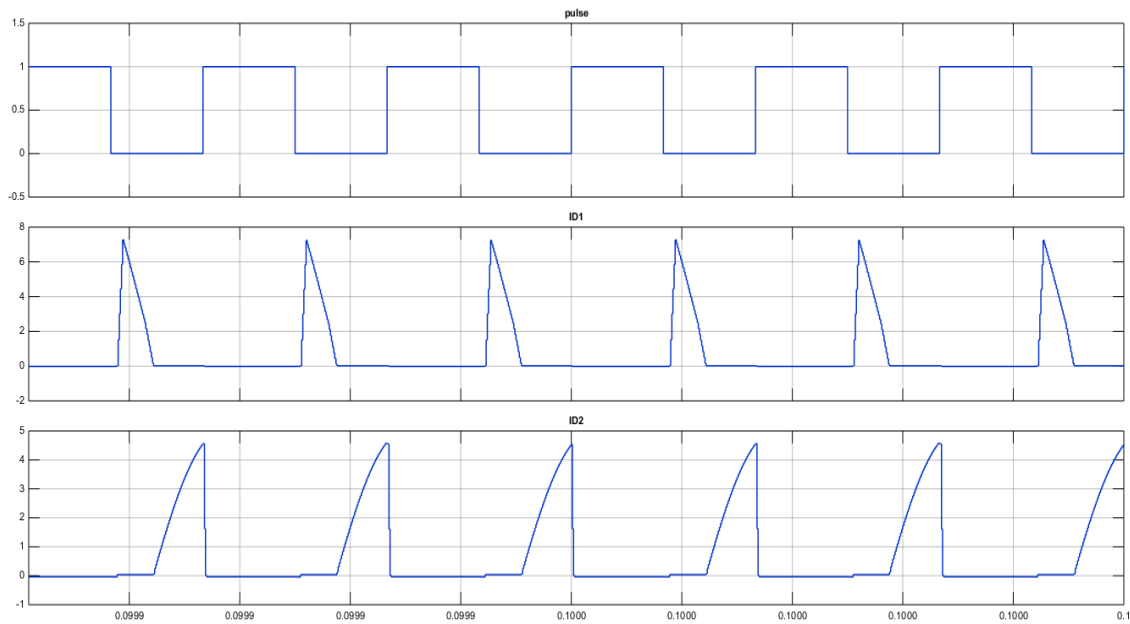


Fig5.2 current flowing through the Diode d1and d2

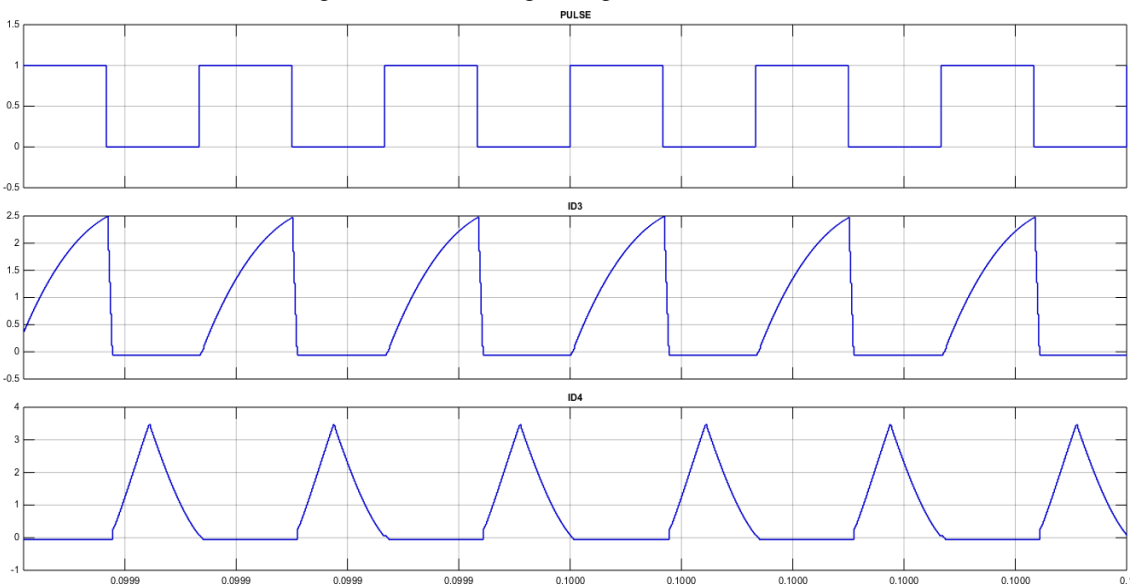


Fig5.3 current flowing through the Diode d3 and d4

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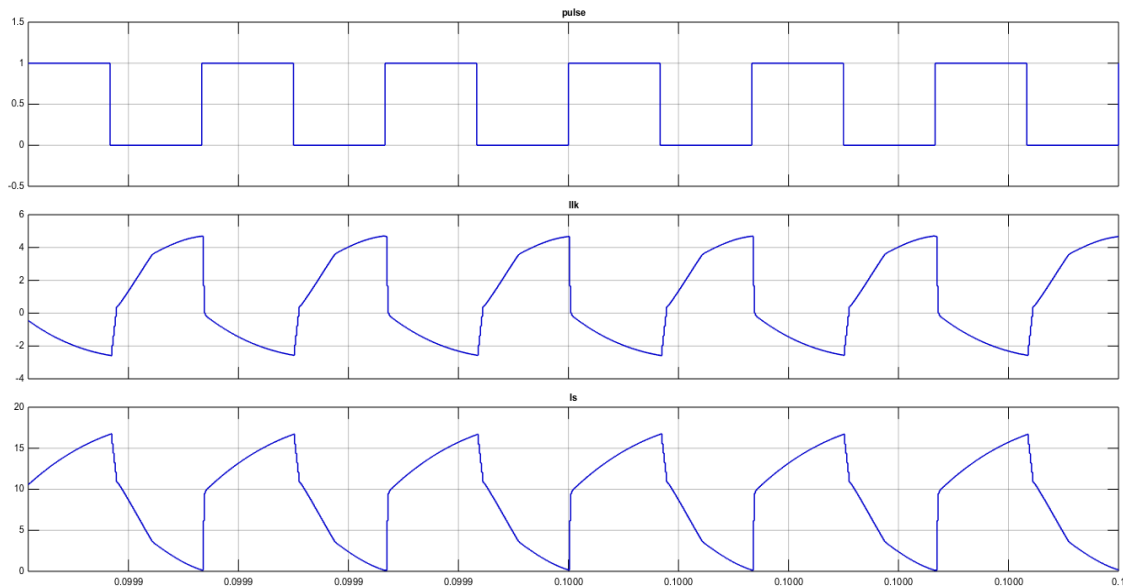


Fig5.4 current flowing through coupled inductor i) leakage current ii) secondary winding current

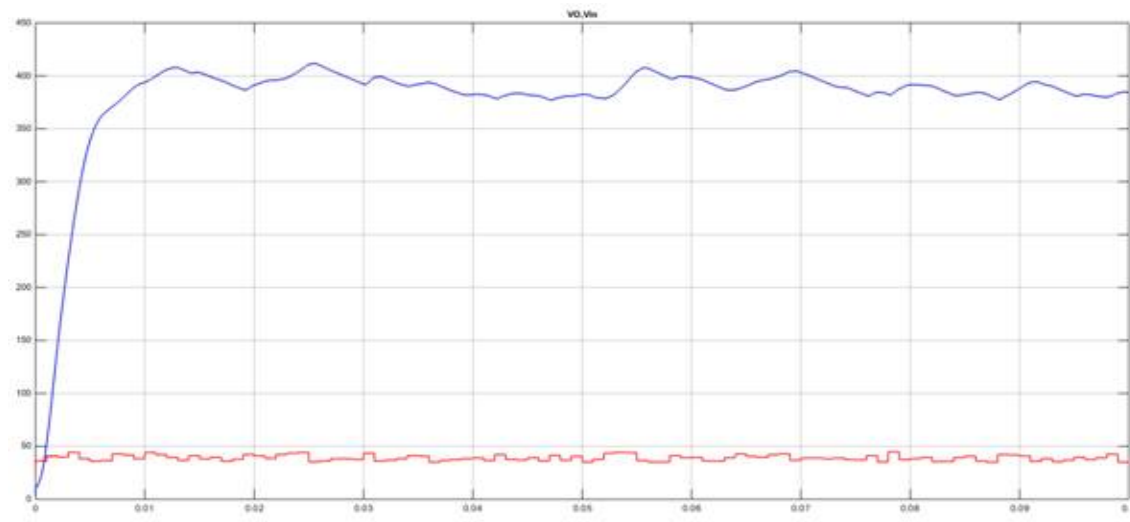


Fig 5.5 Output voltage and input with open loop voltage

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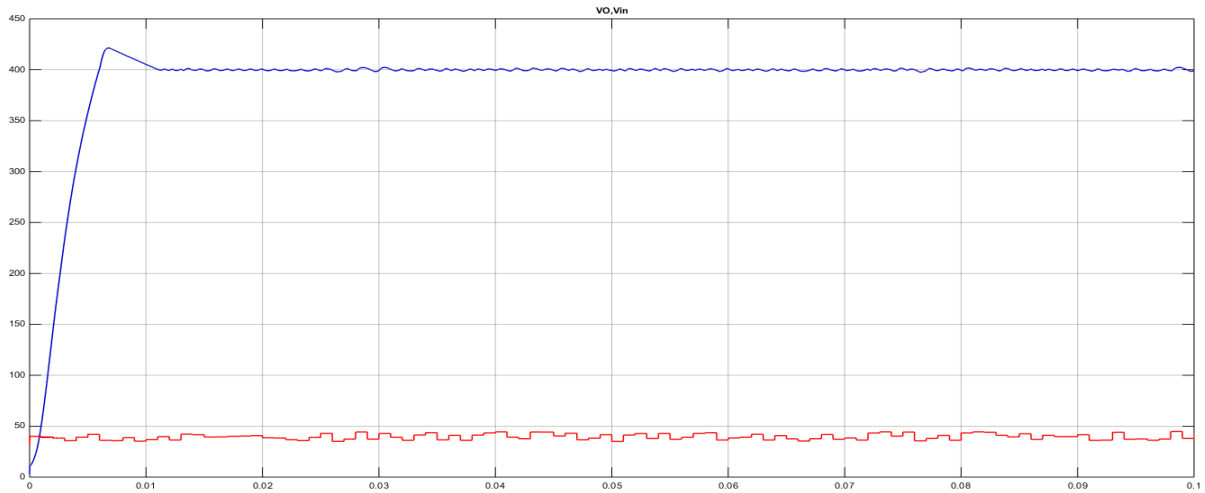


Fig 5.6 Output voltage and input with closed loop voltage

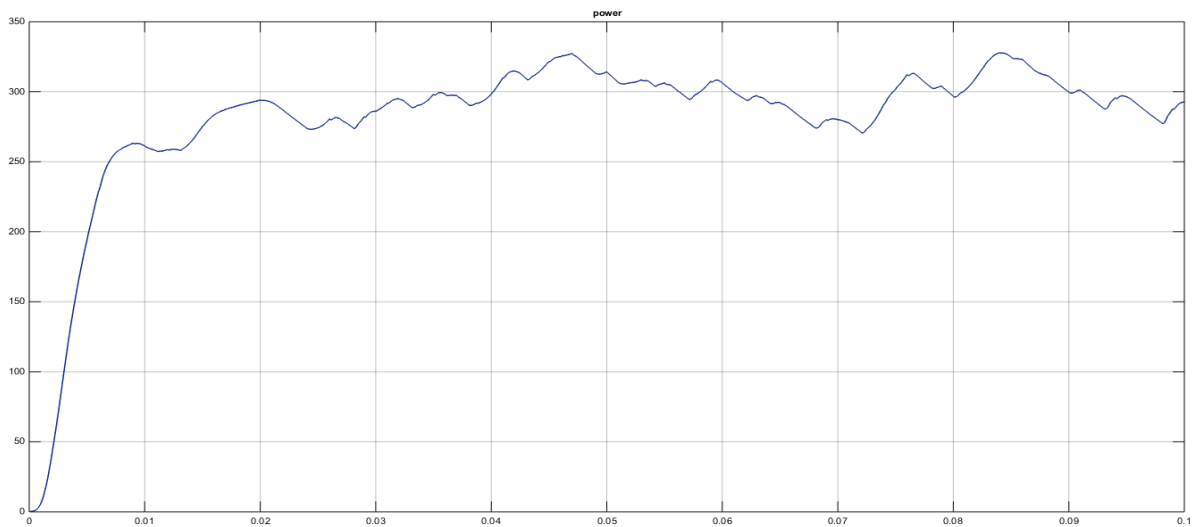


Fig 5.7 Output Power with closed loop

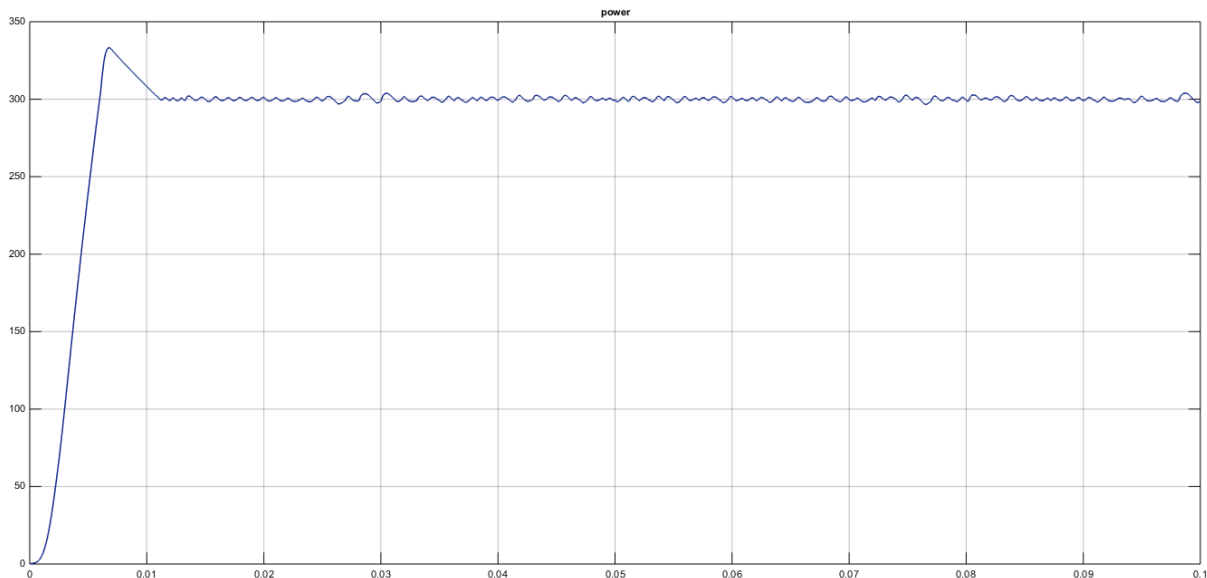


Fig 5.7 Output Power with closed loop

## VI. CONCLUSION

A high step-up dc/dc converter based on integrating coupled inductor and switched-capacitor are proposed for renewable energy applications. The energy stored in the leakage inductance of the coupled inductor is recycled by using switched capacitors. The voltage stress across the main switch is reduced. Here the gate signals are generated using PWM control schemes. In order to load and load regulation. The simulation of the converter with 40V input voltage, 300W power and 400V/7.5A has been carried out using MATLAB software.

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### **BIOGRAPHY**



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