ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

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

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 8, August 2016

A High Step-Up DC-DC Converter Using PV System Based on Integrating Coupled Inductor and Switched-Capacitor

K. Hareesh[1], A.Anil Kumar[2]

PG Student, Department of Electrical and Electronics Engineering. Vaageswai College, Telangana, India

Senior Associate Professor, Department of Electrical and Electronics Engineering. Vaageswai College, Telangana, India

ABSTRACT: High-efficiency Step-Up Converter by using PV system with reduced voltage Stress 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 .. Simulation results are presented to demonstrate the effectiveness of the converter.

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

I.INTRODUCTION

The advent of renewable energy sources like solar and wind based system as clean and viable alternatives to conventional sources such as fossil fuel based energy generation, demands high gain DC-DC converters to step up the voltage significantly to be used either practically as a domestic stand-alone system or for connection to the grid. Initially cascaded and interleaved boost converters (IBC) were used to obtain the required high gain [3]-[4]. These converters however faced inherent problems of high ripple current and high power losses. This prevented higher efficiency at a higher gain when using these topologies. Isolated topologies using transformers or coupled inductors with suitable turns-ratio were used to achieve the required voltage gain. When using transformer the losses are a function of switching frequency, this in turn puts an upper limit on the operating frequency of the converter. Also this increases the size of the converter besides making the converter heavier and costlier. The high current flowing through the boost inductor also imposes large voltage stress across the devices. For efficient utilization of renewable energy, compact non-isolated converters are required. Coupled inductors were used in conjunction with switched capacitors in [2]. The main disadvantage of this topology is that many numbers of components were used. In [1] and [8], coupled inductor was used in conjunction with a voltage multiplier cell.Switched inductor and switched capacitor based topologies were used to reduce the switch stress in [9].The concept of multi-level based DC-DC power conversion proves to be a suitable non-isolated alternative solution to obtain the required high voltage gain and high power level[10]-[12].The main advantage of multilevel conversion is that only low voltage level devices are required as each device only block one voltage level. The advantage of multi-level conversion can further be extended by including a coupled inductor into the converter. This provides further control over the gain. The presence of the coupled inductor in addition to the voltage multiplier reduces the duty cycle required to achieve a particular gain Some literatures have researched the high step-up DC-DC converters that do not incur an extremely high duty ratio. The transformer less DC-DC converters, such as the cascade boost type, the quadratic boost type, the switched-inductor type , the voltage-lift type , the voltage doubler technique , the capacitor-diode voltage multiplier type , and the boost type that is integrated using a switched-capacitor technique . These converters can provide higher voltage gain than the conventional DC-DC boost converter. However, the voltage gain of these converters is only moderately high. If higher voltage gain is required, these converters must cascade more power stages, which will result in low efficiency. The DC-DC flyback converter is adopted to achieve high step-up voltage gain by adjusting the turn's ratio of the transformer

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

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

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 8, August 2016

II. LITERATURE SURVEY

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 leakageinductance 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

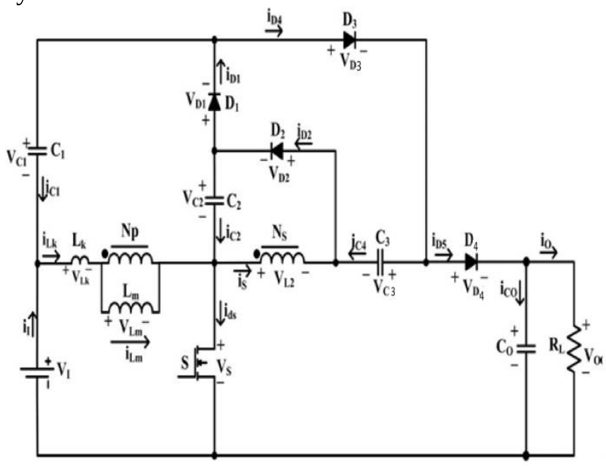


Fig 2.1 Circuit configuration of high-step- up converter

2.2 Features of this converter

A conventional high step-up DC-DC converter with coupled-inductor technique. The structure of this converter is very simple and the leakage-inductor energy of the coupled inductor can be recycled to the output. However, the voltage stresses on switch S1 and diode D1, which are equal to the output voltage, are high. This paper presents a novel high step-up DC-DC converter. The coupled-inductor and voltage-doubler techniques are integrated in the proposed converter to achieve high step- up voltage gain. The features of this converter are as follows:

1. The leakage-inductor energy of the coupled inductor can be recycled.
2. The voltage stresses on the switches are half the level of the output voltage. Thus, the switches with low voltage rating and low ON-state resistance RDS (ON) can be selected.
3. The voltage gain achieved by the proposed converter is double that of the conventional high step-up converter. Under the same voltage gain and duty ratio, the turns ratio of the coupled inductor for the proposed converter can be designed to be less than the conventional high step-up converter.
4. The frequency of the magnetizing inductor current for the proposed converter is double of the switching frequency.

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.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

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

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 8, August 2016

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

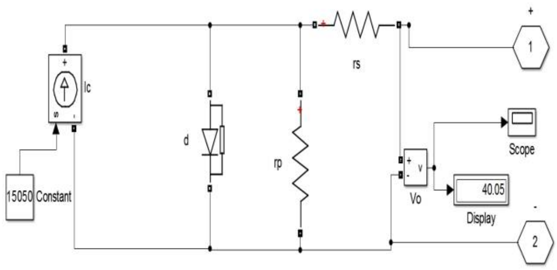
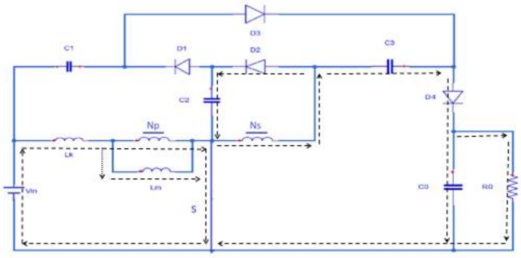


Figure 3.1: Single diode model of a solar cell

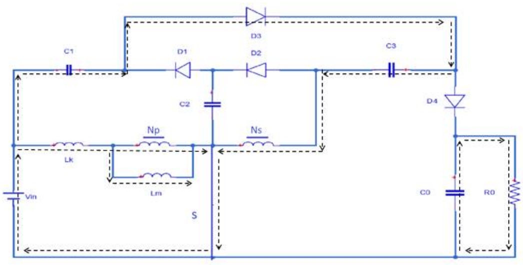
IV.OPERATING PRINCIPLE OF THE PROPOSED CONVERTER

There are five operating modes in one switching period. Fig. 4 shows the current-flow path of each mode of the circuit.
a) Mode I [t0, t1]: In this mode, S is turned on. Diodes D1 and D3 are turned off, and D2 and D4 are turned on. The current-flow path is shown in fig. 4(a). The DC source magnetizes Lm through S. The secondary-side of the coupled inductor is in parallel with capacitor C2. As the current of the leakage inductor Lk increases the secondary-side current of the coupled inductor (is) decreases. The capacitor CO supplies the energy to R0. This interval ends when the secondary-side current of the coupled inductor becomes zero.



4(a) Mode I

b) Mode II [t1, t2]: In this mode, S remains turned on. Diode D1, D2, and D4 are turned off and D3 is only turned on. The current-flow path is shown in fig. 4(b). Vin magnetizes Lm through switch S. So, the current of the leakage inductor Lk and magnetizing inductor Lm increase linearly. Dc source Vin, clamp capacitor and the secondary-side of the coupled inductor are charge the capacitor C3. Output capacitor CO supplies load R0. This interval ends when switch (S) is turned off.



4(b) Mode II

c) Mode III [t2, t3]: In this mode, S is turned off. Diodes D2, and D4 are turned off and D1 and D3 are turned on. The current-flow path is shown in fig. 4(c). The clamp capacitor C1 is charged by using capacitor C2, leakage inductor Lk

 DOI:10.15662/IJAREEIE.2016.0508073

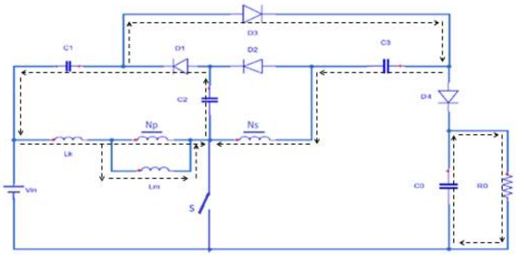
ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

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

(An ISO 3297: 2007 Certified Organization)

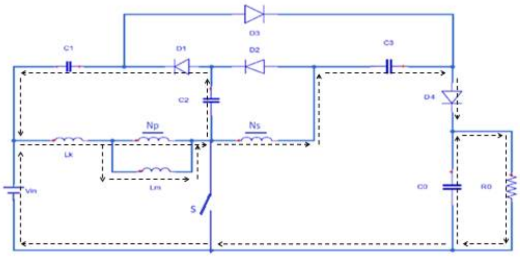
Vol. 5, Issue 8, August 2016

and magnetizing inductor Lm. The currents of the secondary-side of the coupled inductor (is) and the leakage inductor are increased and decreased respectively. The capacitor C3 is still charged through D3. This interval ends when iLk is equal to iLm. Output capacitor C0 provides its energy to load R.



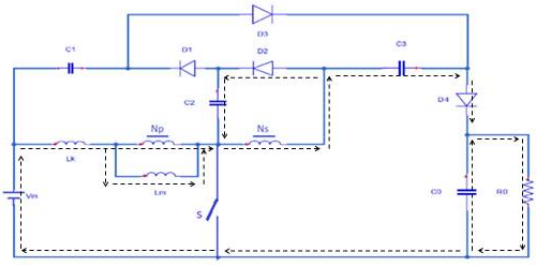
4(c) Mode III

d) Mode IV [t3, t4]: In this stage, S is turned OFF. Diodes D2 and D3 are turned OFF and diodes D1 and D4 are turned ON. Energies of capacitor C2 ,leakage inductor Lk and magnetizing inductor Lm are charge capacitor C1. The currents of the leakage inductor Lk and magnetizing inductor Lm decrease linearly. Also, a part of the energy stored in Lm is transferred to the secondary side of the coupled inductor. The dc source Vin, capacitor C3 and both sides of the coupled inductor charge output capacitor C0 and provide energy to the load R0.



4(d) Mode IV

e) Mode V [t4, t5]: In this stage, S is turned OFF. Diodes D1 and D3 are turned OFF and diodes D2 and D4 are turned ON. The currents of the leakage inductor Lk and magnetizing inductor Lm decrease linearly. Apart of stored energy in Lm is transferred to the secondary side of the coupled inductor in order to charge the capacitor C2 through diode D2 . In this interval the dc input voltage Vin and stored energy in the capacitor C3 and inductances of both sides of the coupled inductor charge the output capacitor Co and provide the demand energy of the load RL. This interval ends when switch S is turned ON.



4(e) Mode V

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.specfications of the implemented model are show in table 1

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

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

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 8, August 2016

PARAMETER	VALUE
Input dc voltage	40 V
Output voltage	400 V
Switching frequency	60kHz
Coupled inductor	Lk=1uH,Lm=300 uH
CapacitosC1,C2,C3,C0	47,47,100,220 uH

The Figure 5.1 shows the circuit simulated.

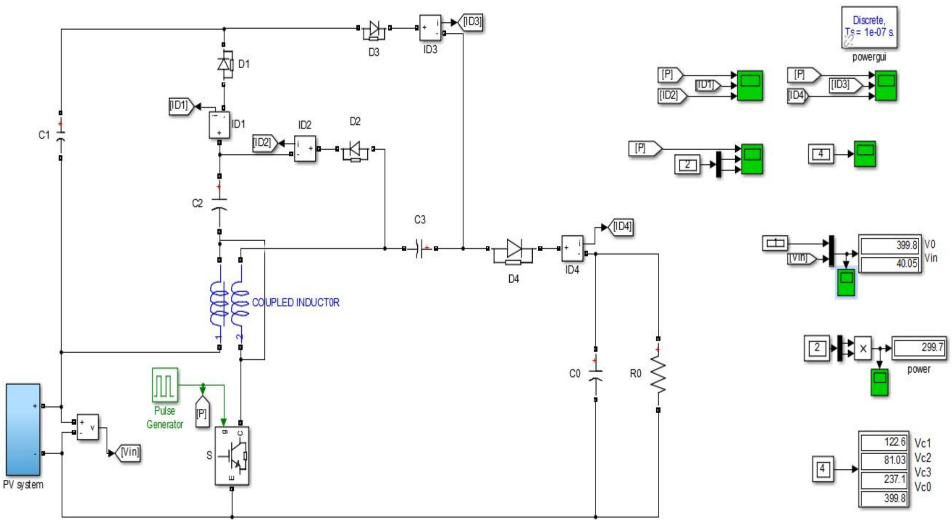


Fig 5.1 Proposed Converter with PV module

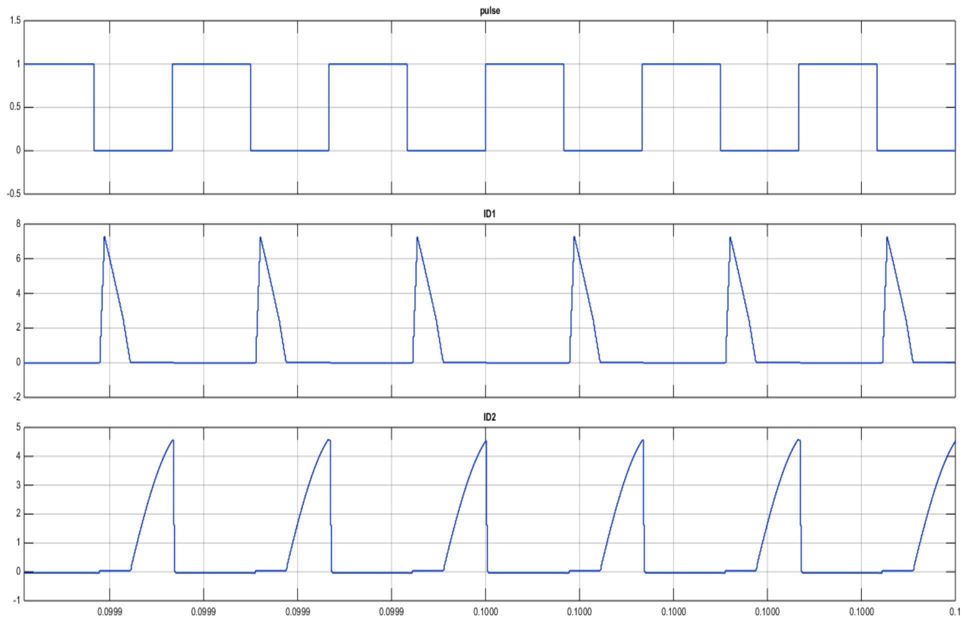


Fig5.2 current flowing through the Diode d1and d2

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

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

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 8, August 2016

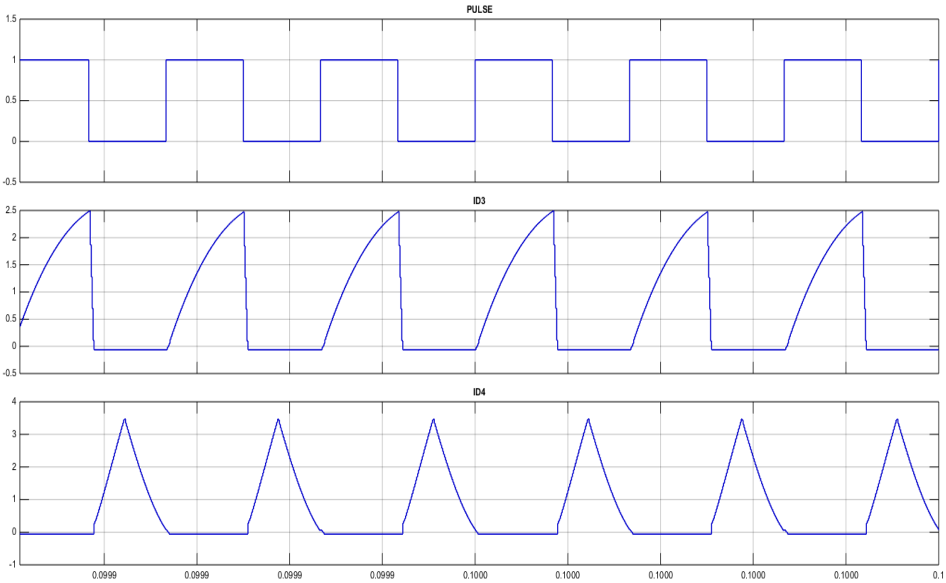


Fig5.3 current flowing through the Diode d3 andd4

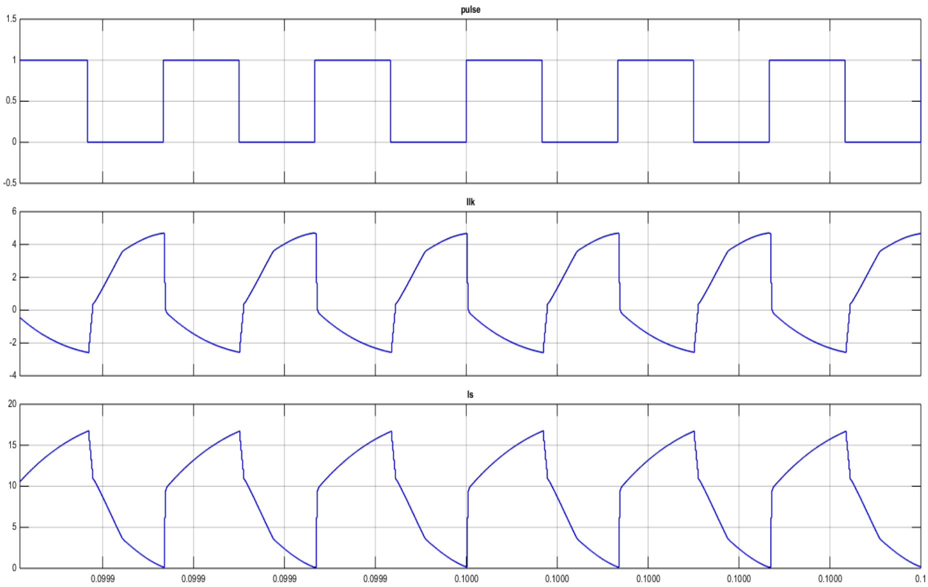


Fig5.4 current flowing through coupled inductor i) leakage current ii) secondary winding current

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

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

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 8, August 2016

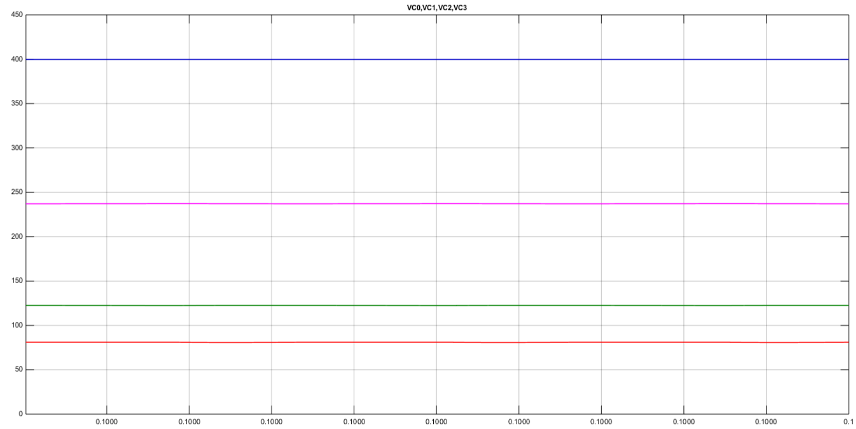


Fig 5.5Votage across the C1, C2, C3 and C0

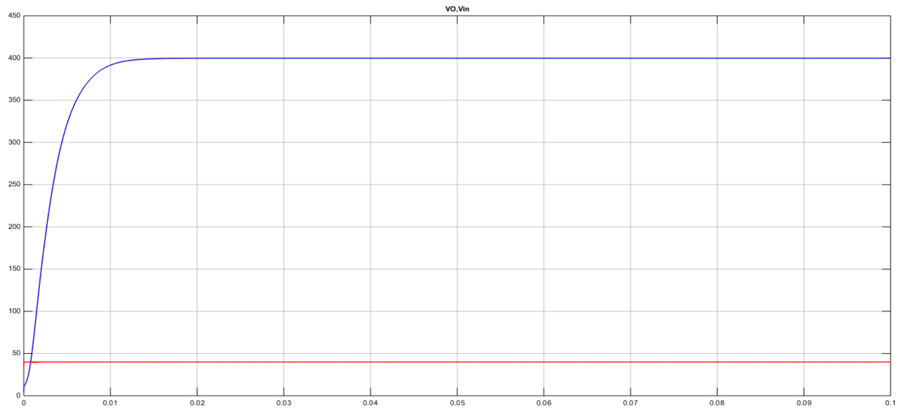


Fig 5.6 Output voltage and input voltage

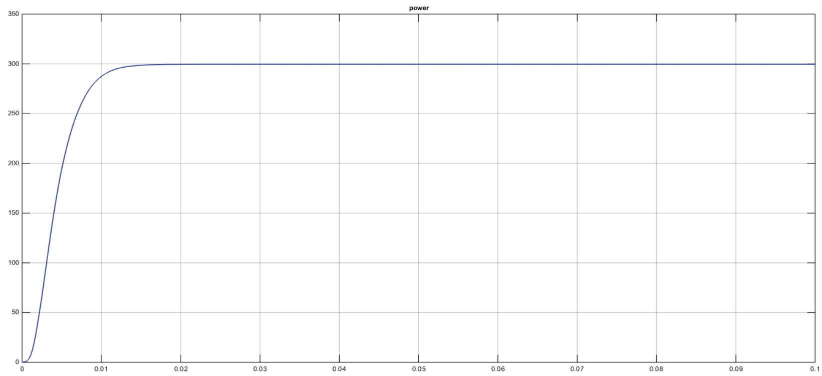


Fig 5.7 Output Power

VI. CONCLUSION

This paper presents a new high-step-up dc/dc converter for renewable energy applications. The suggested converter is suitable for DG systems based on renewable energy sources, which require high-step-up voltage transfer gain. The energy stored in the leakage inductance is recycled to improve the performance of the presented converter. Furthermore, voltage stress on the main power switch is reduced. Therefore, a switch with a low on-state resistance can be chosen. The steady-state operation of the converter has been analysed in detail. Also, the boundary condition has

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

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

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 8, August 2016

been obtained. Finally, Simulation model is implemented which converts the 40-V input voltage into 400-V output voltage. The results prove the feasibility of the presented converter.

REFERENCES

[1] F.Nejabatkhah, S. Danyali, S. Hosseini, M. Sabahi, and S. Niapour, "Modeling and control of a new three-input DC–DC boost converter for hybrid PV/FC/battery power system," IEEE Trans. Power Electron., vol. 27, no. 5, pp. 2309–2324, May 2012.
[2] R. J. Wai and K. H. Jheng, "High-efficiency single-input multiple-output DC–DC converter," IEEE Trans. Power Electron., vol. 28, no. 2, pp. 886– 898, Feb. 2013.
[3] Y. Zhao, X. Xiang, C. Li, Y. Gu, W. Li, and X. He, "Single- phase high step-up converter with improved multiplier cell suitable for half-bridgebased PV inverter system," IEEE Trans. Power Electron., vol. 29, no. 6, pp. 2807–2816, Jun. 2014.
[4] J.H. Lee, T. J. Liang, and J. F. Chen, "Isolated coupledinductor-integrated DC–DC converter with non-dissipative snubber for solar energy applications," IEEE Trans. Ind. Electron., vol. 61, no. 7, pp. 3337–3348, Jul. 2014.
[5] C.Olalla, C. Delineand, andD.Maksimovic,"Performance ofmismatched PV systems withsubmodule integrated converters," IEEE J. Photovoltaic, vol. 4, no. 1, pp. 396–404, Jan. 2014.
[6] C. W. Chen, K. H. Chen, and Y. M. Chen, "Modeling and controller design of an autonomous PV module for DMPPT PV systems," IEEE Trans. Power Electron., vol. 29, no. 9, pp. 4723–4732, Sep. 2014.
[7] Y. P. Hsieh, J. F. Chen, T. J. Liang, and L. S. Yang, "Analysis and implementation of a novel single-switch high step-up DC–DC converter," IET Power Electron., vol. 5, no. 1, pp. 11–21, Jan. 2012.
[8] Y. Zhao, W. Li, Y. Deng, and X.He, "High step-up boost converter with passive lossless clamp circuit for non-isolated high step-up applications," IET Power Electron., vol. 4, no. 8, pp. 851–859, Sep. 2011.
[9] I. Laird and D. D. Lu, "High step-up DC/DC topology and MPPT algorithm for use with a thermoelectric generator," IEEE Trans. Power Electron., vol. 28, no. 7, pp. 3147–3157, Jul. 2013.
[10] R. J. Wai, C. Y. Lin, C. Y. Lin, R. Y. Duan, and Y. R. Chang, "Highefficiency power conversion system for kilowattlevel stand-alone generation unit with low input voltage," IEEE Trans. Ind. Electron., vol. 55, no. 10, pp. 3702–3714, Oct. 2008.
[11] L. S.Yang,T. J. Liang, and J. F.Chen, "TransformerlessDC–DCconverter with high voltage gain," IEEE Trans. Ind. Electron., vol. 56, no. 8, pp. 3144–3152, Aug. 2009.
[12] Ali Ajami, Hossein Ardi, and Amir Farakhor" A Novel High Step-up DC/DC Converter Based on Integrating Coupled Inductor and Switched-Capacitor Techniques for Renewable Energy Applications", IEEE TRANSACTIONS ON POWER ELECTRONICS, VOL. 30, NO. 8, AUGUST 2015.

BIOGRAPHY

Mr. A.Anil Kumar, working as senior Associate Professor in Vaageswari College of Engineering, Karimnagar, Telangana. He received the AMIE graduate degree in Electrical Engineering . And he received M.Tech in Electrical Power systems specialization from JNTU Anantapur A.P. At present, pursuing Ph.D from JNTU Hyderabad. He has rich experience of 19 years in teaching for Engineering students at UG and PG level . His areas of interest are Power Systems, Network Theory, Power Electronics and Electrical Machines etc.

Mr.Kanaparthi Hareesh, received B.Tech degree in Electrical and Electronics Engineering from Vidya jyothi institute of technology, Moinabad, Rangareddy, Telangana,received the diploma in electrical and electronics engineering at Govt. Polytechnic college Nizamabad, A.P.. And currently pursuing M.Tech in Power Electronics at Vaageswari College of Engineering, Telangana, India, My areas of interest are Power Systems, and Power Electronics, Electrical Machines.