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 4, April 2016

A Novel Grid Connected DC Quadrupler Converter

Liza Joseph[1], Kiran.K.C[2], Amith Jyothis[3], Alan Mathew George[4]

B.Tech Student, Dept. of EEE, Adi Shankara Institute of Engineering and Technology, Kalady, Kerala, India[1]

B.Tech Student, Dept. of EEE, Adi Shankara Institute of Engineering and Technology, Kalady, Kerala, India[2]

B.Tech Student, Dept. of EEE, Adi Shankara Institute of Engineering and Technology, Kalady, Kerala, India[3]

Asst. Professor, Dept. of EEE, Adi Shankara Institute of Engineering and Technology, Kalady, Kerala, India[4]

ABSTRACT: In this paper, a grid connected voltage quadrupler transformer-less dc-dc converter with high voltage transfer gain and reduced semiconductor voltage stress is suggested. A novel transformer-less adaptable voltage quadrupler dc-dc converter having reduced semiconductor voltage stress and more voltage transfer gain is suggested. The efficiency of conventional boost converter is limited by duty ratio for higher output voltage. In theory, when duty ratio is closed to unity, the voltage gain will be infinity. Even though the switching losses are large; the parasitic resistances of inductor and equivalent series resistance (ESR) of capacitors are also constrained the voltage gain and efficiency.

This paper proposes an inverter with an H- bridge topology which is connected to quadrupler converter and produces 50Hz ac supply. It integrates quadrupler boost converter and grid to maintain the advantage of an automatic current allotting capability simultaneously. Furthermore, the voltage stress on active switches and diodes in the proposed converter can be greatly reduced to improve overall conversion efficiency.

KEYWORDS: Automatic current allotting,High step-up converter,Transformer-less, Voltage quadrupler.

I.INTRODUCTION

This paper suggests the design and implementation approach of a DC-DC Quadrupler with an H- bridge inverter for grid applications. The first stage is a high step-up highefficiency DC-DC Quadruplerconverter. The module inverter structure is a single phase H-bridge system is then connected to a grid line of 50 Hz frequency. The DC-DC converter raises the input low voltage to a high voltage level and the maximum voltage achieved in this stage. The second stage is a single phase H-bridge inverter. TheH-bridgeinverter transforms DC voltage from the first stage into sinusoidal voltage waveform for gridconnection, and its abnormal state detection and voltage ripple control are also achieved in this stage. The micro controller Atmega 16 is used to give switching pulses to converter and inverter.

Quadrupler converter is provided with a switching frequency of 40 kHz and the inverter is provided with a switching frequency of 50Hz. Finally, a prototype circuit with input range from 6V to 9 V to obtain 150V DC voltage outputfrom quadrupler converter and 165VAC / 50 Hz, 50 W output from inverter is implemented to verify the feasibility of this system.

II.SYSTEM MODEL AND ASSUMPTIONS

DC QUADRUPLER CONVERTER

The proposed DC Quadrupler converter utilizes input-parallel output-series configuration. It provides a much higher voltage gain without using an extreme large duty cycle. The suggested converter cannot only achieve high voltage gain with reduced components but also reduces the voltage stress of both active switches and diodes.The converter uses 2 MOSFET switches.

1)All components are taken as model components.

2) The capacitors are sufficiently large, so that the voltages across them can be taken as constant approximately.

3) The system under steady state is operating oncontinuous current mode and with minimum duty ratio .5 for high step-up voltage purpose.

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 4, April 2016

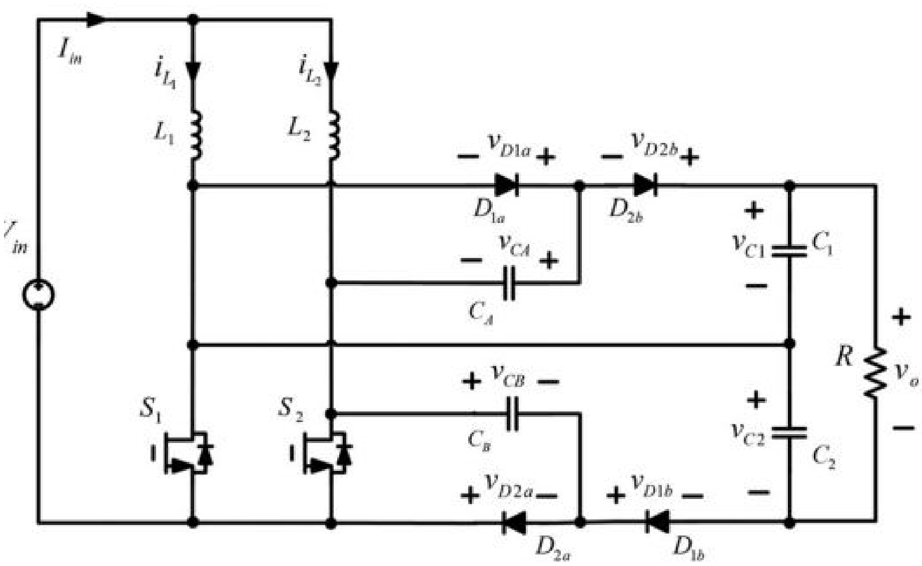

Fig.1. Equivalent circuit of a DCQuadruplerConverter

MODE 1:For mode 1, switches S1 and S2 are turned ON,D1a,D1b,D2a,D2bare all OFF. C_A & C_B are isolated.V_{C1} and V_{C2} charged to maximum voltage. Inductors L1 & L2 are also charged to maximum value.

MODE 2:For this operation mode, switchS1 leftovers conducting and S2 is turned OFF. Diodes D2a and D2b become conducting.

$$V_{C1}=V_{CA}+V_{CB} \tag{1}$$

MODE 3:For this operation mode, bothS1 and S2 are turned ON.CapacitorsC_A& C_B are isolated.V_{C1} and V_{C2} charged to maximum voltage. Inductors L1 & L2 are also charged to maximum value.

MODE 4:For this operation mode, switch S2 remains conducting and S1 is turned OFF. Diodes D1a and D1b develop conducting.

$$V_{C2}=V_{CB}+V_{CA} \tag{2}$$

DC-AC INVERTER

The DC-AC inverter consists of aH-bridge inverter comprises of four switches and with a low-pass filter. This is used for switch driven. The HPWM method uses two different converting frequency signals to drive MOSFET switches respectively. There are only two of four switches operated at lower frequency which is equal to grid frequency. Other two switches are operated by the modulation signals came from the compared result of sinusoidalsignal and triangle carrier signal.

MODE 1: During positive half cycle, switches S1 and S4 are active and other switches S2 and S3 are turned off. The switch S4 is subject to duty cycle modulation control. The average voltage Vab among the points a and b can be derived as

$$Vab = D\ Vbus \tag{3}$$

D is the duty ratio obtainedfrom the compared results of the sinusoid control signal V Control and the triangle carrier signal Vtri. When Vtri>Vcontrol, S4 is turned on, and vice versa.

MODE 2: During negative half cycle, both switches S2 and S3 are active and other switches S1 and S4 are turned off. The switches S3 is subject to duty cycle modulation control.When Vtri>Vcontrol, S3 is turned on, the average voltage Vab among the points a and b can be derived as:

$$Vab = -DVbus \tag{4}$$

The $f_s$is switching frequency and the f_g is the modulation frequency.

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 4, April 2016

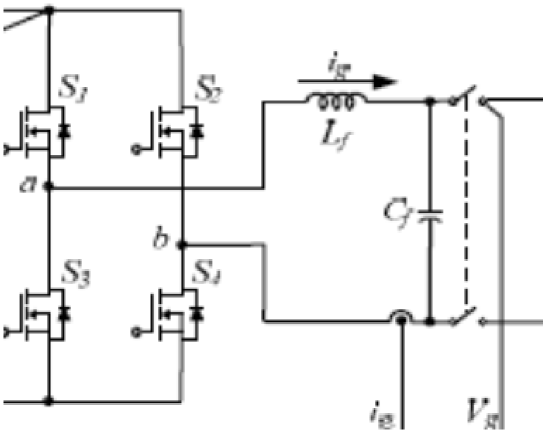

Fig.2.Equivalent circuit of an H-bridge inverter

m_a = Vcontrol / Vtri (5)

m_f= fs /fg (6)

Because of switches S1 and S2, are at commuted at low frequency, the switching losses are significantly reduced than others and the inverter efficiency is then improved.

The control strategy for the all four switches is very simple. The control strategy can easily be implemented on a microcontroller.The required switching signals generated by Hybrid Pulse Width Modulation method where the width of each pulse is varied.The switching signals are generated by comparing a sinusoidal amplitude reference signal with a triangular carrier wave of frequency fc.

III.MATLAB DESIGN AND SIMULATION

A] DC QUADRUPLER CONVERTER WITH PID CONTROLLER

Simulations were performed using MATLAB to show the behaviour of a prototype of the present invention. The switching frequency for the dc-dcquadrupler boost converterstage was chosen to be 40 kHz.The PID controller is used in feedback in order to speed-up the response. Thus it achieves high step-up gain with the reduction in the rise time and steady state error.

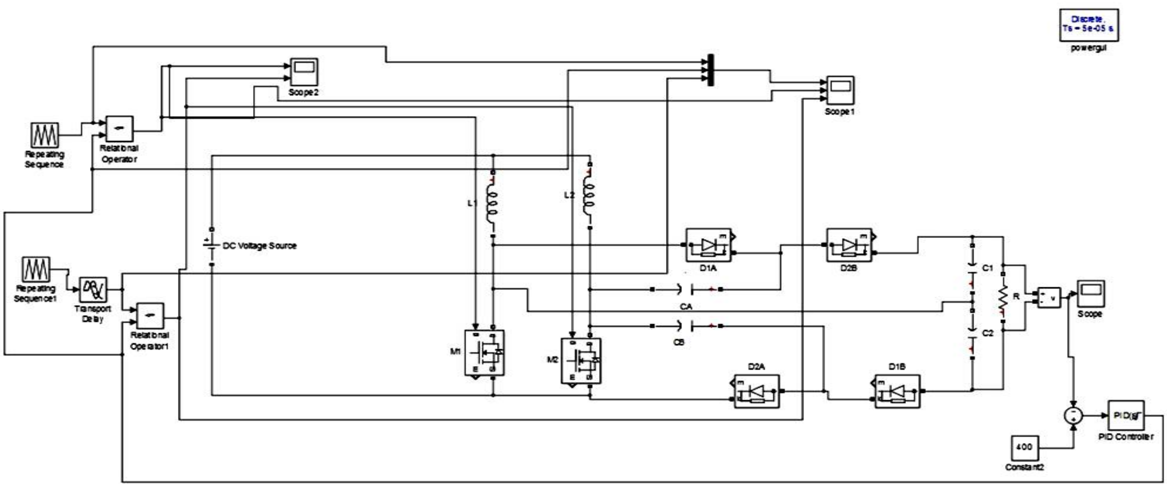

Fig.3. Simulink model of DC Quadrupler Converter with PID controller

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 4, April 2016

B] SINGLE PHASE H-BRIDGE INVERTER

Simulations were performed using MATLAB to show the behaviour of a prototype of the present invention. The switching frequency of both switches S1 andS2 is 50Hz and for S3 and S4 is 40kHz. The gate pulses are generated by using Hybrid Pulse Width Modulation methods.

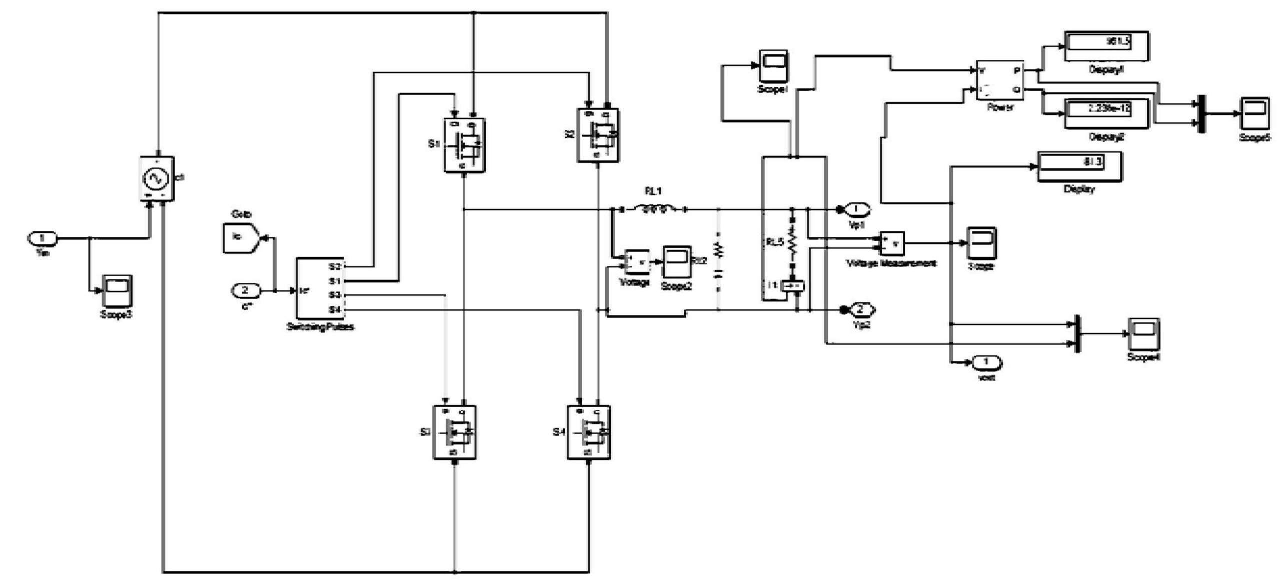

Fig.4.Simulink Model of single phase H-bridge Inverter

C] GRID CONNECTED DC QUADRUPLER CONVERTER

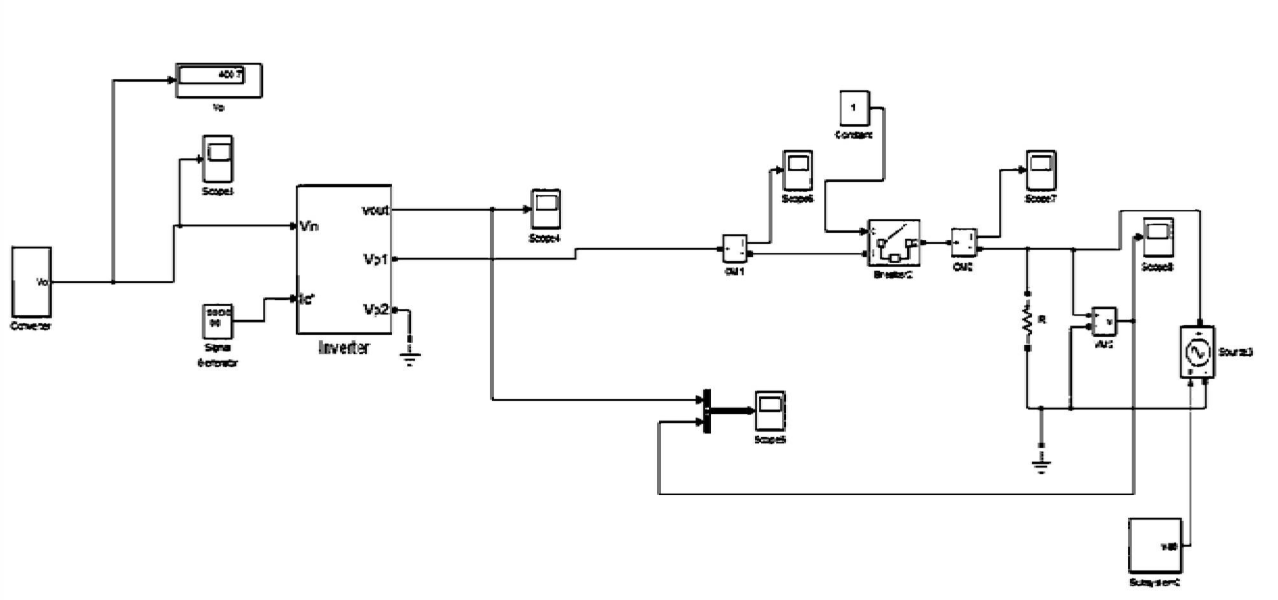

Fig.5.Simulink Model of Grid connected DC Quadrupler Converter

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 4, April 2016

This paper suggests an inverter with an H- bridge topology which is connected to quadrupler converter and produces 50Hz ac supply. It integrates quadrupler boost converter and grid to maintain the advantage of an automatic current allotting capability simultaneously.

IV.RESULT AND DISCUSSION

OUTPUT VOLTAGE WAVEFORM OF DC-DC CONVERTER WITH PID CONTROLLER

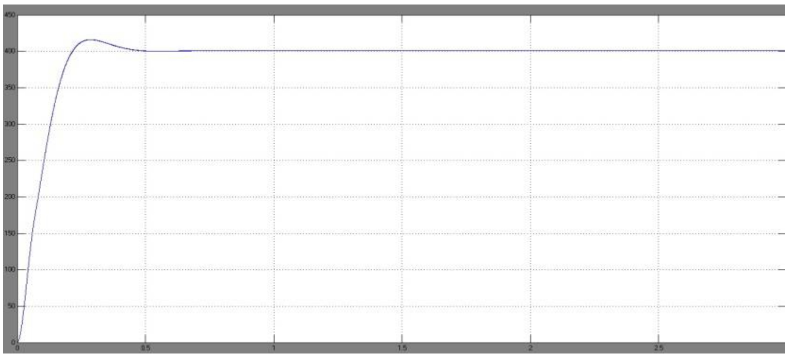

Fig.6.Output Voltage of DC/DC Quadrupler converter

The result shown in Fig.6 illustrates the output voltage of the suggested dc-dc boost converter. An input of around 6V is given to this converter andgives an output voltage is around 400V which means that this converter is high step upand highly efficient for high voltage applications.

OUTPUT VOLTAGE AND CURRENT WAVEFORM OF H-BRIDGE INVERTER

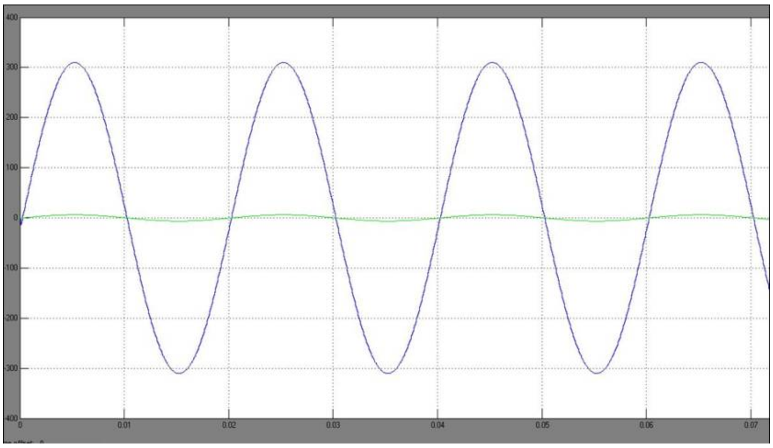

Fig.7.Output Voltage and Current waveform of H-bridge inverter

. The H-bridge inverter transforms DC voltage from the first stage into sinusoidal voltage waveform for gridconnection, and its abnormal state detection and voltage ripple control are also achieved in this stage. The micro controller Atmega 16 is used to give switching pulses to converter and inverter.

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 4, April 2016

Fig.8.Output voltage of Inverter stage

The dc-dc converter with voltage quadrupler was presented and the operation and features have been described. Experimental results were discussed with simulation on MATLAB software. The proposed method eliminates the problems of extreme duty ratio or complexity of circuits comparing to conventional topology. Also, the suggested converter has the following advantages compared to conventional high boost converters: low voltage stress, higher boost rate, higher efficiency, and several modified circuits for high voltage applications. The constant-frequency control is achieved with the employment of coupled inductors that couples the current paths of the boost converter and forces them to be virtually identical.

This converter achieves high step up voltage gain, of up to 16 times the level of input voltage and also drop in the rise time and steady state error is achieved due use of PID controller in feedback. This particular design protects the installers and users from electrical hazards.

V.CONCLUSION AND FUTURE SCOPE

This methodology can achieve more output level for a PV panel.It integrates quadrupler boost converter and grid to maintain the advantage of an automatic current division capability simultaneously. Furthermore, the voltage stress of active switches and diodes in the suggested converter can be greatly reduced to enhance overall conversion efficiency.This high boost converter is connected to the inverter for distributing power to AC loads.

The future scope can be as follows

1)Replacing the Atmega 16 Microcontroller by a DSP controller TMS320LF2407A,we can achieve

a) Synchronized checking for the initialsettings of the inverter.

b) Abnormal state detection on various grid conditions.

2)By designing proper passive filter, harmonic content in the output can be reduced to a great extent.

Thus the power losses are minimized and efficiency is improved by connecting a PV panel directly to the main AC grid.

REFERENCES

[1] C. T. Pan,"A Novel Transformer-less Adaptable DC Quadrupler with low voltage stress," IEEE Transactions on Power Electronics , Vol.29 , no. 9,pp.4787-4796,Sep.2014.

[2] Q. Zhao and F.C. Lee,"High-efficiency,high step-up dc-dc converters," IEEE Trans.Power Electron., Vol. 18, no. 1, pp.6573, Jan.2003.

[3] R. J.Wai andR. Y. Duan, "High step-up converter with coupled-inductor," IEEE Trans. Power Electron., Vol. 20, no. 5, pp. 1025–1035, Sep. 2005.

[4] L. S. Yang, T. J. Liang, H. C. Lee, and J. F. Chen, "Novel high step-upDC–DC converter with coupled-inductor and voltage-doubler circuits," IEEE Trans. Ind. Electron., Vol. 58, no. 9, pp. 4196–4206, Sep. 2011.

[5] W. Li and X. He, "Review of Non-isolated High-Step-Up DC/DC Converters in Photovoltaic Grid-Connected Applications"IEEE Trans. Ind. Electron.,Vol.58, no.4, pp. 12391250,Mar.2011.

[6] W. Li and X. He, "Review of Non-isolated high-step-up DC/DC converters in photovoltaic grid-connected applications," IEEE Trans. Ind. Electron., Vol. 58, no. 4, pp.12391250, Apr. 2011.