IJIREEICE

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Innovative Research in
Electrical, Electronics, Instrumentation and Control Engineering

REPSE-17

National Conference on Sustainable Development in Renewable Energy Sources and Power System Engineering

Sri Venkateshwara College of Engineering, Bengaluru

Vol. 5, Special Issue 3, May 2017

Boost Derived Hybrid Converter for Simultaneous DC and AC Applications using Single DC Source Supply

Abhilash M[1], Dr. J Satheesh Kumar[2]

PG Student, Dept of Electronics & Instrumentation Engg, Dayananda Sagar College of Engineering, Bengaluru, India[1]

Associate Professor, Dept of Electronics & Instrumentation Engineering, Dayananda Sagar College of Engineering, Bengaluru, India[2]

Abstract: The paper proposes a hybrid converter topology which can supply both dc and ac loads from a solitary dc input. These topologies are derived from boost converter by replacing the controlled switch with a voltage-source-inverter bridge network. The resulting hybrid converter has lesser number of power switches to provide both ac and dc outputs with an increased reliability. And the proposed converter have better power processing density and reliability, which can be well suited for systems with simultaneous both ac and dc loads,The proposed converter in this paper, is called boost-derived hybrid converter (BDHC) as it is derived from the conventional boost converter. A modified PWM control strategy is described for BDHC.

Keywords: Hybrid converter, power switches, Voltage Source Inverter, modified PWM.

I. INTRODUCTION

Nano/Micro grid architecture are small autonomous system formed by integrating various distributed energy sources like solar, wind, fuel cells, biomass etc.[1] The architecture are being increasingly incorporated in smart residential electrical power systems. These systems involves different type of loads- DC as well as AC loads which are efficiently interfaced with conventional or non-conventional energy sources using power electronic converters.[2] There are several DC-DC converter configuration were already proposed such as buck, boost, Sepic and Cuk.. A DC-DC converter with a high voltage gain is desirable in many modern residential applications. For example: An application of a hybrid converter can be to power an AC fan and a LED lamp both at the same time from a solitary DC input in a single stage. Generally, when there is a need to step up a DC voltage a boost converter is usually chosen. To achieve a high voltage gain, the duty cycle of the switch of boost converter must be larger resulting in high conduction losses and degrading the converter efficiency. Inverter section may be either voltage sourced or current sourced.[3] Voltage source inverters are commonly preferred in micro grid applications.

II. BLOCK DIAGRAM

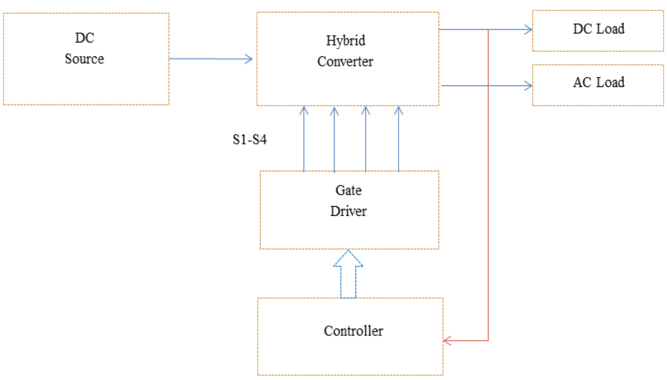

Fig. 1: Block diagram of proposed topology

Hybrid converter can be realized by replacing the controlled power switch with an single phase voltage source inverter (VSI) bridge network. The proposed circuit modification is applied to a boost converter. The below block diagram shows the proposed topology.

III. PRINCIPLE OF OPERATION

The Boost operation of the proposed converter can be realized by turning on both switches of any particular leg simultaneously. The Hybrid converter, during inverter operation, has the same circuit states as a conventional voltage source inverter (VSI).

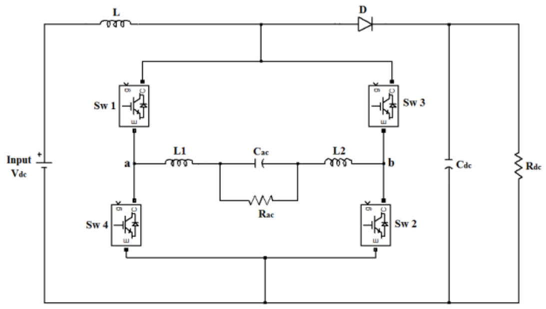

Fig 2: circuit diagram of BDHC.

The Hybrid converter has three distinct switching intervals as:

1. Shoot-through interval
2. Power interval
3. Zero interval

Shoot-through interval:

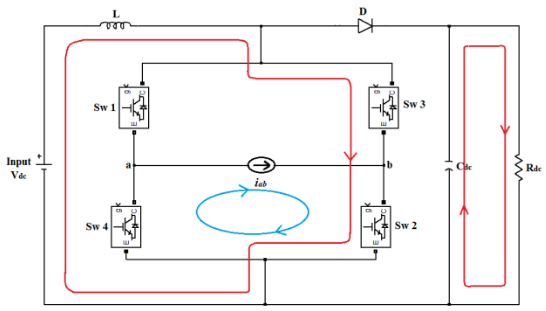

Fig 3: current flow diagram in shoot through interval

The shoot-through interval occurs when both the switches (either Sw1-Sw4 or Sw3-Sw2) of any particular leg are turned on at the same time. The duration of the shoot-through interval decides the boost converter duty cycle. The diode "D" is reverse biased during this period. The inverter output current circulates within the bridge network switches.

Power interval:

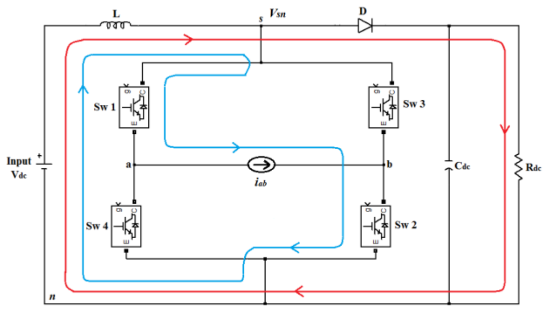

Fig 4: current flow diagram in power interval

IJIREEICE

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Innovative Research in
Electrical, Electronics, Instrumentation and Control Engineering
REPSE-17

National Conference on Sustainable Development in Renewable Energy Sources and Power System Engineering
Sri Venkateshwara College of Engineering, Bengaluru
Vol. 5, Special Issue 3, May 2017

The power interval, occurs when the inverter current enters or leaves the bridge network at the switch node "s". The diode "D" conducts during this period, and the voltage at the switch node (Vsn) is equal to the Vdcout (neglecting the diode voltage drop). In this interval, either Sw1-Sw2 or Sw3-Sw4 is turned on.

Zero interval:

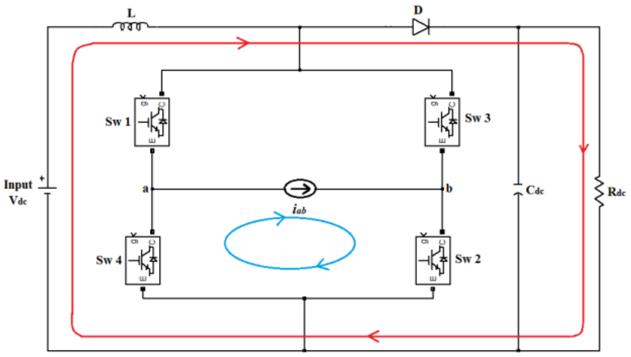

Fig 5: current flow diagram in zero interval

The zero interval occurs when the inverter current circulates among the bridge network switches and is not sourced or sunk. The diode "D" conducts during this interval.

IV. CONTROL STRATEGY

Modified PWM Strategy for Hybrid Converter

The controlling pulses for the switches of the hybrid converter can be generated by summing the pulses generated for the boost converter and voltage source converter. The switching pulses for boost operation are generated by comparing the carrier and dc reference. And for voltage source inverter carrier and the sine reference are compared. For the proposed hybrid converter pulses generated for boost operation and VSI are combined using OR gate for all the four power switches.[2]

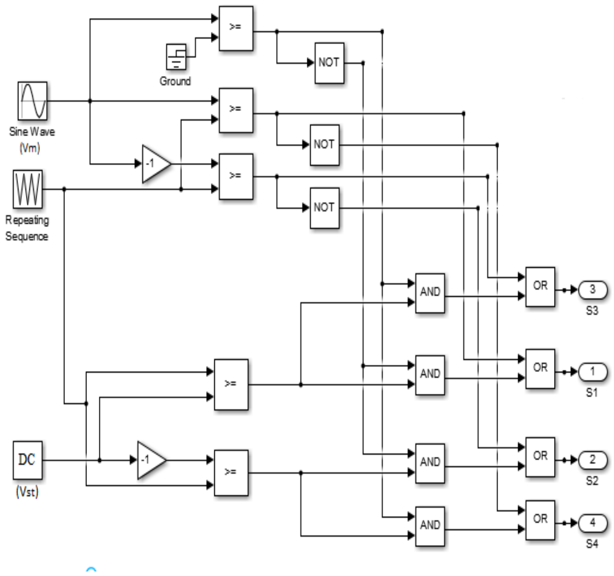

Fig 6: Simulink model for PWM generation circuit

In this scheme, the shoot-through is realized by gating-on both the switches of a single leg at the same time. The switching strategy involves turning on only one leg at a time in order to achieve shoot-through. Another alternative is to turn on all the switches during shoot-through.

IJIREEICE
ISSN (Online) 2278-1021
ISSN (Print) 2319-5940
International Journal of Innovative Research in
Electrical, Electronics, Instrumentation and Control Engineering
REPSE-17
National Conference on Sustainable Development in Renewable Energy Sources and Power System Engineering
Sri Venkateshwara College of Engineering, Bengaluru
Vol. 5, Special Issue 3, May 2017

V. ADVANTAGES

1) Inherent shoot through protection:
   To avoid shoot through in PWM controlled VSI, a blank time is introduced. In this period both upper and lower switches in a phase leg are off. So short circuit can be avoided and switches are not damaged due to high current and temperature.
2) The use of separate dead time is not necessary as it has the special properties of the inherent shoot through capability. The delay time provided by the dead time circuit is to avoid conduction overlap of switching devices.
3) The total number of power semiconductor devices used in the circuit is less compared to conventional system thereby the total switching and conduction losses are reduced.
4) The circuit is capable of supplying both AC and DC loads simultaneously thereby multi output behavior is achieved by the hybrid converter.
5) Achieves high voltage gain because of the less voltage stress on switches.

VI. EXPERIMENTAL VERIFICATION

A complete list of parameters values for prototype is given in below table.

Parameter	Attributes
Power rating (P_{dc} + P_{ac})	500 W + 90 W
Input voltage (V_{dcin})	48 V
Output (Vdcout)	100 V
Voltage (Vacout)	30 V
DC Load (R_{dc})	20 Ω
AC Load (R_{ac})	10 Ω
Switching Frequency	10 KHz
Input Inductor (L)	5 mH
DC Capacitor (C)	1 mF
AC Filter Inductor (L1 & L2)	500 µH (each)
AC Filter Capacitor (C_{ac})	10 µF

Table 1: Design specifications of the BDHC

VII. SIMULATION STUDIES AND RESULTS

1. Open loop hybrid converter

V_{dc}=100volts,V_{ac}=30volts,V_{in}=48 V, freq=50 Hz

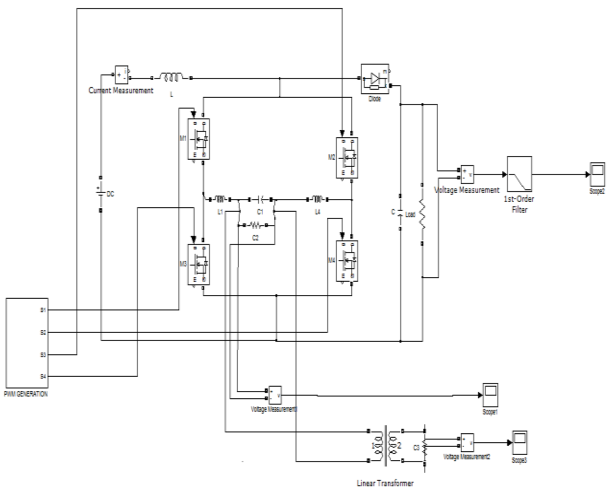

Fig 7: Simulink model for open loop hybrid converter

IJIREEICE

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Innovative Research in
Electrical, Electronics, Instrumentation and Control Engineering
REPSE-17

National Conference on Sustainable Development in Renewable Energy Sources and Power System Engineering
Sri Venkateshwara College of Engineering, Bengaluru
Vol. 5, Special Issue 3, May 2017

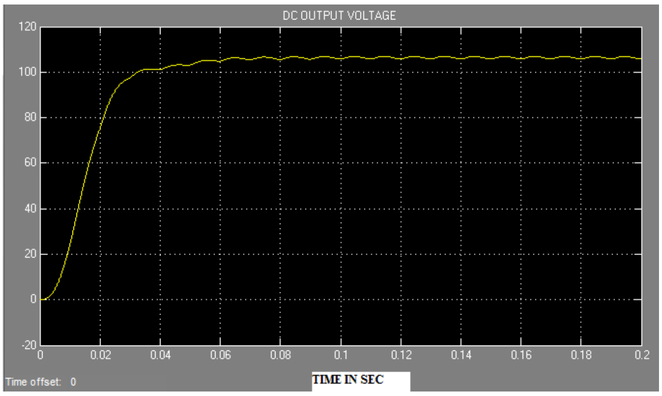

Fig 8: DC output voltage waveform for open loop BDHC

Fig 8 shows the DC output voltage waveform for the open loop BDHC. The output voltage depends upon the duty cycle. In this simulation we are getting a 110V DC output for 0.4 duty cycle.

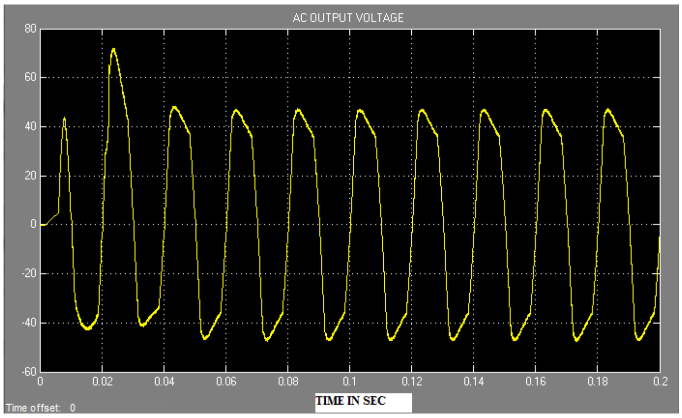

Fig 9: AC output voltage waveform for open loop BDHC

Fig 9 shows AC output voltage which depends upon the modulation index. In this simulation we are getting a 30V(rms) AC output. In this project we are boosting the AC output voltage to 230V(rms) as shown In fig 10 by using the transformer.

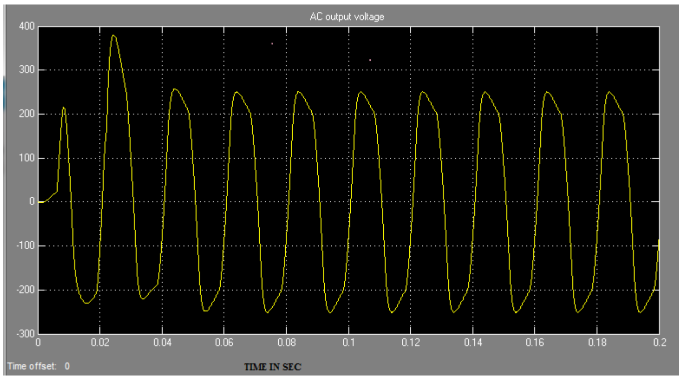

Fig 10: AC output voltage waveform with transformer for open loop BDHC

2. Closed loop hybrid converter

In this closed loop hybrid converter(fig 11) we use a PI controller which compares the reference voltage and measured voltage and takes the corrective action for occurred error.

Fig 12 shows controller part of closed loop BDHC. PI controller sends the corrective signal to the PWM generation circuit and control the pulses to get the desired result.

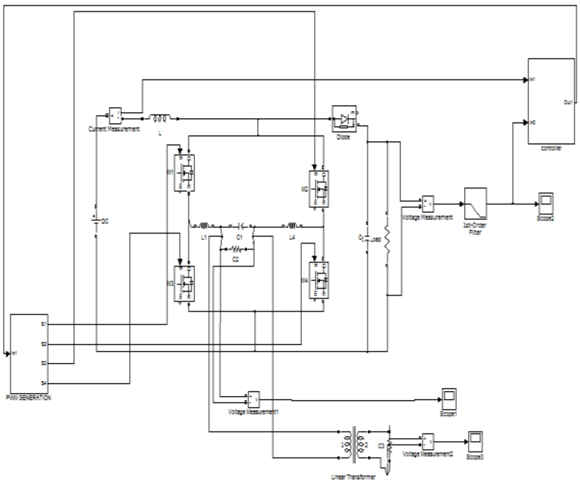

Fig 11: Simulink diagram for closed loop BDHC

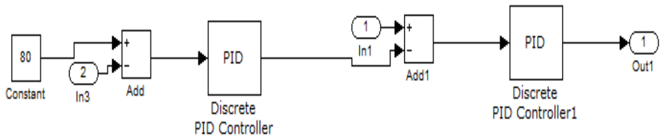

Fig 12: Simulink diagram of controller in closed loop BDHC

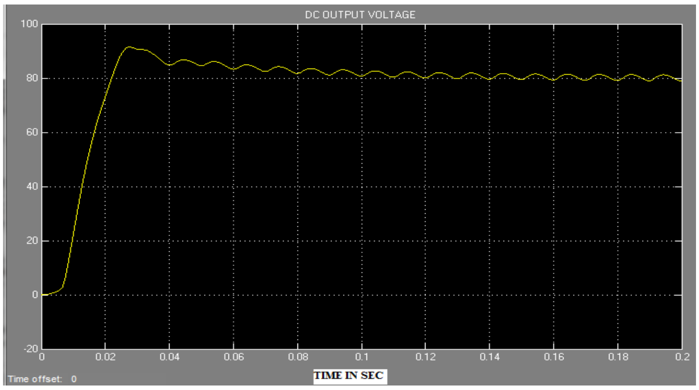

Fig 13: DC output voltage waveform for closed loop BDHC with reference voltage of 80V

VIII. CONCLUSION

This paper has proposed hybrid converter topology which can supply both ac and dc loads from a solitary dc input in a single stage. The various advantages of this converter stage aredescribed and compared with conventional system.Experimental results verify the operation of the hybrid converter in an open loop and closed loop.

REFERENCES

[1] Olive Ray and Santanu Mishra, "Boost derived hybrid converter with simultaneous dc and ac outputs," IEEE Trans. Ind. Appl., vol. 50, no. 2, pp.1082-1093, Mar./Apr. 2014.
[2] R. Adda, Santanu K. Mishra "Analysis and PWM Control of Switched Boost Inverter," IEEE Trans. Ind. Appl., vol. 39, no. 12 pp. 444–56, Dec. 2013.
[3] R. Adda, S. Mishra and A. Joshi, "A PWM Control Strategy for Switched-Boost Inverter," in Proc. IEEE ECCE 2011, Phoenix, pp. 991-996, Sept. 2011.
[4] F. Z. Peng, M. Shen, and Z. Qian, "Maximum boost control of the Z-source inverter," IEEE Trans. Power Electron., vol. 20, no. 4, pp. 833– 838, Jul. 2005.
[5] M. Shen, J. Wang, A. Joseph, F. Z. Peng, L. M. Tolbert, and D. J. Adams, "Constant boost control of the Z-source inverter to minimize current ripple and voltage stress," IEEE Trans.Ind. Appl., vol. 42, no. 3, pp. 770–778, May/Jun. 2006.
[6] R. W. Erickson and D. Maksimovic, Fundamentals of Power Electronics,2nd ed. New York, NY, USA: Springer-Verlag, 2001.
[7] J. A. Morales-Saldaña, R. Galarza-Quirino, J. Leyva-Ramos, E. E. Carbajal-Gutierrez, and M. G. Ortiz-Lopez, "Modeling and control of a cascade boost converter with a single switch," in Proc. IEEE IECON, Paris, France, Nov. 7–10, 2006, pp. 591–596.