IJIREEICE
ISSN (Online) 2321-2004
ISSN (Print) 2321- 5526
International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering
NFTPCOS-18
National Conference on Future Technologies in Power Control and Communication Systems
College of Engineering Perumon, Kollam, Kerala
Vol. 1, Special Issue 2, March 2018

# Single Stage High Gain Buck- Boost Inverter With Coupled Inductor and Maximum Power Point Tracking

**RemyaRemeshan M R,Arun Kishore W C,Anumol George**

PG Scholars Dept. of EEE,Government Engineering College Bartonhill, Tvm,India

Associate. Professor, Dept. of EEE, Govt engineering college Barton Hill, Trivandrum, India

Assistant professor(Adhoc), Dept. of EEE, Govt engineering college Barton Hill, Trivandrum, India

**Abstract-**Converter system that does both dc–dc conversionand dc–ac conversion in a single stage is called a single-stage converter system (SSCS). The two stage power conversionwill be done in a single stage by this converter. The maindrawback of the two stage conversion system are complexity in control, low efficiency ,and large size. Maximum power point tracking also incorporated to track maximum power at different isolation .Incremental l conductance method is the method for maximum power point tracking used in the proposed system. The proposed system produce output voltage higher or lower than the input voltage .The proposed system has low switching loss, high gain, and compact in size. Coupled inductor is used to produce high gain . The proposed system produce output voltage of 230V.The simulation is done in MTLAB simulation results arepresented to validate the proposed idea.

**Keywords**-Single-stage, Gridconnected, Buck-boost, Inverter.

## I. INTRODUCTION

Fossil fuels area accumulated at a specific location which may or may not be closer to the load centers .So ,an efficient electrical power transmission system is needed to provide power to the loads which are far away from generating stations. The rate of rise in power demand overloads the available transmission system and may cause blackouts. Distribution power generation using Photovoltaic (PVs) becomes an alternate solution to the above problems In order to deliver power from PV to loads/grid a suitable power conversion system (PCS) is essential. Several two stage grid connected PCS are presented earlier . TSCS has drawbacks such as less reliability (owing to more number of components), more losses, large size and high cost. The main drawback ofthese topologies is, they are not suitable for low input voltage applications due to their limited gain. A converter with coupled inductor using Zsource inverter principle is presented in , but this topology needs more passive components. A single stage boost dc-ac inverter is proposed in which the load is connected differentially across the two same input boost converters which are operating at 180 degrees apart. This topology possesseveral drawbacks such as high switching losses and Electro Magnetic Interference (EMI) problems.A coupled inductor based converter topologies are presented in order to have more gain. But these topologies are limited to low power applications due to the presence of magnetic components. Normally coupled inductors are used for high voltage gain, but the leakage inductance associatedwith them creates several problems like high stress on switching components, energy loss.Several topologies areproposed which can alleviate the aforementioned problems associated with coupled inductors. In this paper, a single stage buck-boost inverter using a single coupled inductor is presented, It has several desirable features like high gainlow switching lossand compact size . It can be used in high power transfer conditions without much stress across the switches.

## II. SINGLE STAGE HIGH GAIN DC-AC INVERTER

The proposed topology uses a coupled inductor in order achieve high gain. Out of all active switches only one switch operates in Sinusoidal Pulse Width Modulation (SPWM) and remaining switches (S1, S2, S3&S4) operate at output voltage frequency with 50% duty cycle c. During positive half cycle of output voltage, switches (S2& S4)will be turned on and switches(S1& S3)will beturned off. Similarly during negative half cycle of output voltage, switches (S1&S3) will be turned on and switches (S2&S4) will be turned off. Since these switches (S1, S2, S3&S4) operate at output voltage frequency, the switching losses associated with them are less.

IJIREEICE

ISSN (Online) 2321-2004
ISSN (Print) 2321- 5526

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

NFTPCOS-18

National Conference on Future Technologies in Power Control and Communication System

College of Engineering Perumon, Kollam, Kerala

Vol. 1, Special Issue 2, March 2018

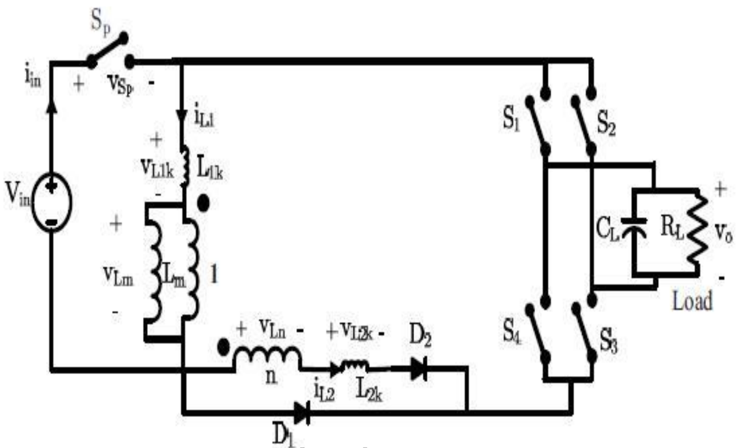


Fig 1: Proposed Buck Boost inverter

## III.OPERATING PRINCIPLE OF BUCK-BOOST INVERTER

A. Mode 1 (t0 to t1):

In this mode the inductor (Lm) gets charged by source voltage Vin through switch SP . Diodes (D1&D2) are reverse biased. Current in the mutual inductance (Lm) rises linearly in this mode. Output capacitor(CL)discharges through load(RL).

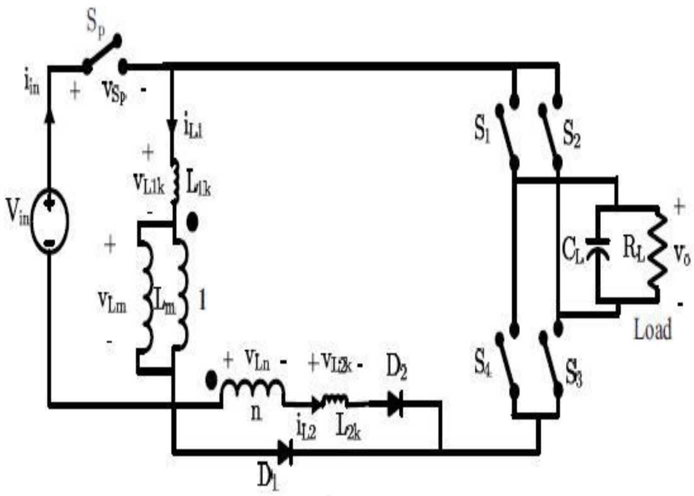


Fig2. mode 1

B. Mode 2 (t1 to t2):

This mode starts when switch (Sp) is turned off. Diodes (D1& D2)become forward biased. The leakage energyassociated with the leakage inductance (L1k) will be delivered to load in this mode. The switch voltage rises to Vin+vo as it is clamped between Vin and vo. A voltageof [−vo−vLm] will appear across leakage inductance(L1k), which will resets the leakage inductance (L1k). So current in leakage inductance(L1k) decreases . In the same time current in leakage inductance (L2k) increases. The difference of these currents takes by the diode (D1) during this interval. This mode ends when currents in both inductors become equal. At the end of this interval diode (D1) becomes reverse biased.

IJIREEICE
ISSN (Online) 2321-2004
ISSN (Print) 2321- 5526
International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering
NFTPCOS-18
National Conference on Future Technologies in Power Control and Communication System
College of Engineering Perumon, Kollam, Kerala
Vol. 1, Special Issue 2, March 2018

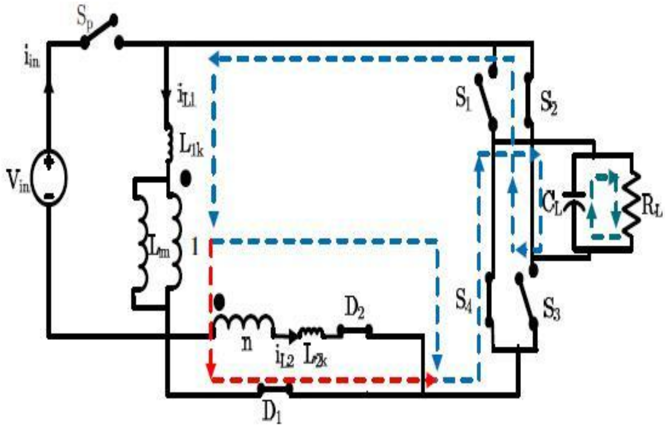


Fig3. mode 2

C. Mode 3 (t2 to t3):

In this mode diode (D1) will be in reverse biased mode and diode (D2) will be in forward biased mode. During this mode both inductors come in series to supply load voltage. The current in both leakage inductors is same and starts decreasing. This mode ends when the switch (Sp) is turned on again.

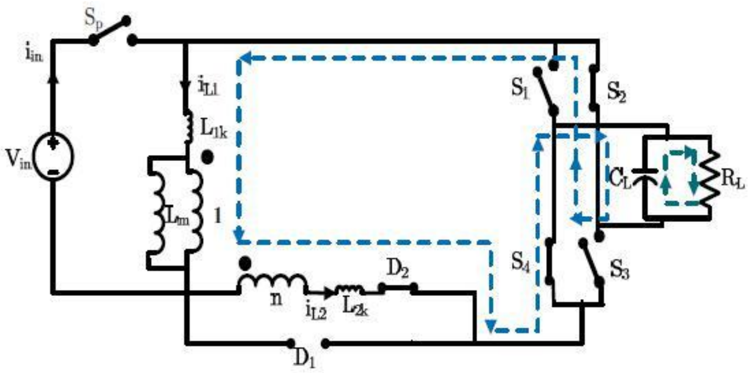


Fig4.mode 3

C .Mode 4 (t3 to t4):

When switch is turned on, diode (D1) will be in reverse biased condition only. Diode (D2) still continues to conduct due to the current in the leakage inductor (L2k). This mode ends when the current in inductor L2k becomes zero. Currents through each inductor (iL1 & iL2), voltages across each inductor (vL1 & vL2) ,currents through diodes (iD1 & iD2) and gating pulses over a switching period given. The same topology, when switch (Sp) is operated with SPWM with twice the output voltage frequency .

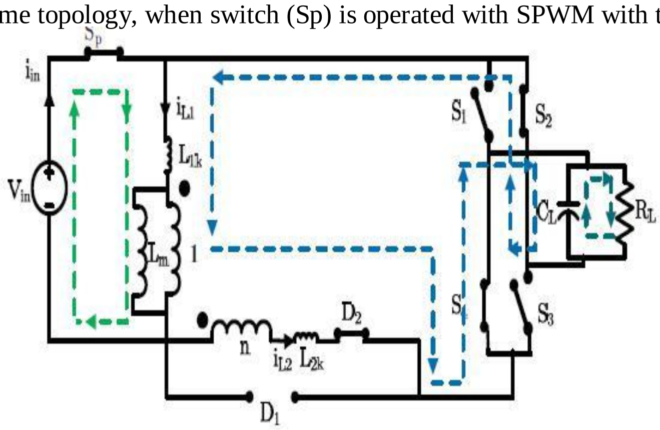


Fig 5.mode 4

## IV. DESIGN OF PROPOSED BUCK BOOST INVERTER

During the operation of the presented system, the GCSS acts as a current source inverter that pumps sinusoidal current into the filter capacitor (Cf ) across the grid. Determination of reference current waveform through inductor (L1 ) for the system to operate in CCM is calculated as follows . Assuming 100%efficiency and unity power factor operation, it implies the following.

PV output power = Power delivered to the grid

$$V_{pv} I_{ref} = V_g I_g \sin^2 (wt) \quad (1)$$

$$I_{ref} = \frac{V_g I_g \sin^2 (wt)}{V_{pv}} \quad (2)$$

where Vg is grid voltage amplitude, Ig is grid current amplitude and Vpv is PV array voltage which is assumed to be ripple free. Iref is the current that has to be tracked by inductor (L1 ) i.e. IL1ref = Iref. Let IL1 /2 be the allowable current rise from nominal current through inductor (L1 ).

L1 can be written as $$L1 = \frac{T_s V_{pv} v_{g(max)}}{\Delta I_{L1} [V_{pv} (1 + n) + v_{g(max)}]} \quad (3)$$

L2 can be calculated from L1 as

$$L2 = n^2 L1 \quad (4)$$

## V.SIMULATED PERFORMANCE OF THE PROPOSED BUCK BOOST INVERTER

A 2kW proposed converter topology is simulated and tested with both R load and R-L loads using MATLAB/ SIMULINK and the parameters are shown in TABLE1 The system is tested under different irradiation levels Obtained simulation results are shown in fig7. . below gives the simulation results corresponding to R load.. it is observed that at each condition, the system is tracking MPP with minimum ripple in the PV power. THD of the obtained output voltage waveform for R load is 1.5% and for R-L load is 1.7%, considering upto switching frequency.it is observedthat at each condition, the system is tracking MPP with minimum ripple in the PV power. Voltage across Cf(vcf), grid current (ig) and grid voltage (vg ) are shown in Fig. 7,it is observed that both (vcf) and (ig) are varying according to the tested conditions. From Fig. 7, it is confirmed that the system is delivering maximum power obtained from PV to grid efficiently with small ripple

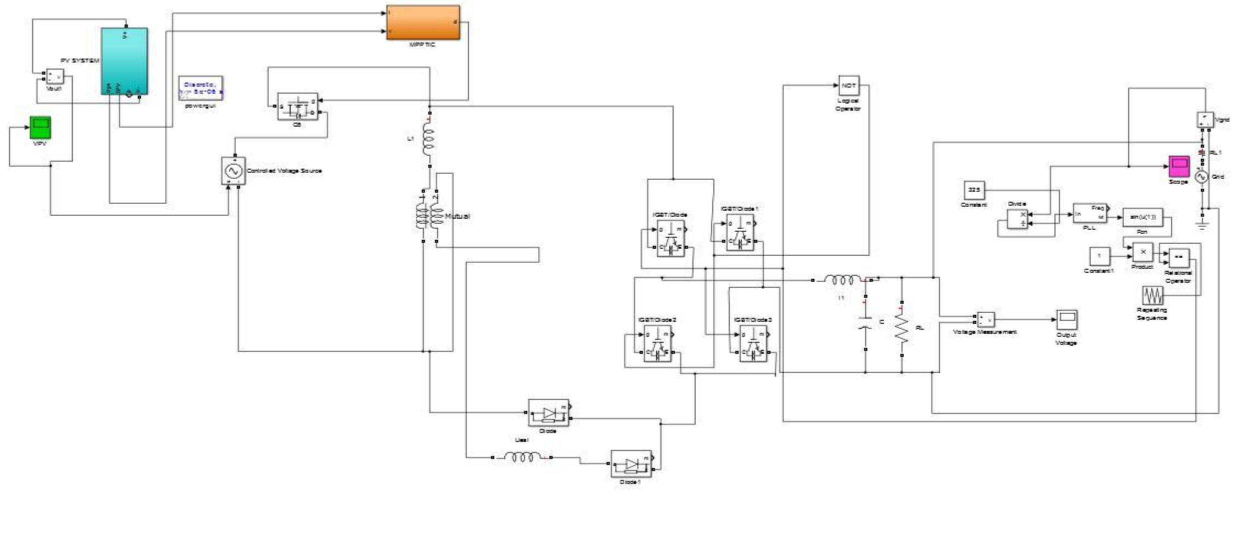

Fig 6: Proposed Buck boost inverter

TABLE I. SIMULATION PARAMETERS

| Parameter | Value |
|---|---|
| Input voltage | 48 V |
| Output voltage | 230 V(RMS) |
| Output voltage frequency | 50 Hz |
| Switching frequency of the switch ($S_p$) | 50 kHz |
| Number of turns on primary | 1 |
| Number of turns on secondary | 2 |
| Inductance ($L_1$) | 12.5 $\mu$H |
| Inductance ($L_2$) | 50 $\mu$H |
| Coefficient of Coupling | 0.95 |
| Output capacitance ($C_L$) | 30 $\mu$F |
| R Load | 26.45 $\Omega$ |
| R-L Load | 30 $\Omega$, 2 mH |

## VI .SIMULATION RESULTS

From the waveforms, it is confirmed that the presented system is tracking MPP at each isolation condition using incremental conductance method. From Fig.7, it is confirmed that the system is delivering maximum power obtained from PV to grid efficiently with small ripple. it is clear that primary inductor current (iL1 ) is in continuous conduction mode and is following voltage template.

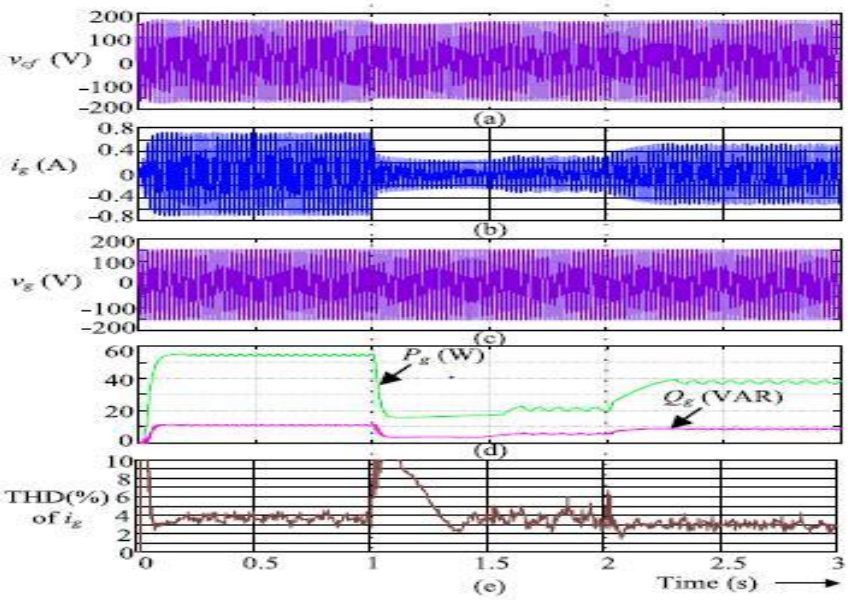


Fig7 simulation result

## VII. EXPERIMENTAL SETUP AND RESULTS

In order to verify the GCSS, a 2KWprototype is developed inthe laboratory. Switch (Sp) is implemented using power MOSFET (K16E60W). Diodes (D1 and D2 ) are implemented using power diodes (MSR1560). Switches (S1, S2, S3 and S4) are implemented using power IGBTs (STGF7NB60SL). Pulses given for all active switches.Grid is emulated using ELGAR programmable power source. Large lengthwaveforms are captured using LECROY44MXs-B Mixed Signal Oscilloscope, steady state waveforms of vg and igare captured using Agilent 3034A Mixed Signal Oscilloscope and THD of igis measured using FLUKE Power Quality Analyzer. Circuit parameters shown in TABLE II are used in the experimental conditions. Before delivering MPP power to grid, the GCSS needs to be synchronized with the grid. The GCSS gets into synchronization with the grid .

IJIREEICE

ISSN (Online) 2321-2004
ISSN (Print) 2321- 5526

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

NFTPCOS-18

National Conference on Future Technologies in Power Control and Communication Systems

College of Engineering Perumon, Kollam, Kerala

Vol. 1, Special Issue 2, March 2018

## VIII. CONCLUSION

Single stage high gain buck-boost inverter topology is presented. From the simulation results, it is clear that thepresented GCSS can deliver power from PV to the grid effectively while continuously tracking the MPP. A diode(D1) is used to bypass the leakage energy of the coupled inductor to the output side load, so that circuit will be free from adverse effects of leakage energy. Experimentalresults further confirm the effective operation of presented GCSS under low insolation conditions. Simulation resultsare presented for both R load and R-L load. Features of this topology include high gain,low switching loss and compact size.

## IX.REFERENCES


- J. Parikh and K. Parikh, "Growing pains: Meeting India's energy needs in the face of limited fossil fuels," IEEE Power Energy Mag., vol. 10, no. 3, pp. 59–66, May 2012.
- D. Meneses, F. Blaabjerg, O. Garcia, and J. Cobos, "Review and comparison of step-up transformerless topologies for photovoltaic AC-module application," IEEE Trans. Power Electron., vol. 28, no. 6, pp. 2649–2663, Jun. 2013.
- S. Jain and V. Agarwal, "A single-stage grid connected inverter topology for solar PV systems with maximum power point tracking," IEEE Trans.Power Electron., vol. 22, no. 5, pp. 1928–1940, Sep. 2007.
- S. Jain and V. Agarwal, "New current control based {MPPT} technique for single stage grid connected {PV} systems," Energy Convers. Manage., vol. 48, no. 2, pp. 625–644, 2007.
- R. Caceres and I. Barbi, "A boost DC-AC converter: analysis, design, and experimentation," IEEE Trans. Power Electron., vol. 14, no. 1, pp. 134–141, Jan 1999.
- N. Kasa, T. Lida, and H. Iwamoto, "Maximum power point tracking with capacitor identifier for photovoltaic power system," in Proc. IEE Electr.Power Appl. Conf., 2000, pp. 497–502.
- Y. Huang, M. Shen, F. Peng, and J. Wang, "Z-source inverter for residential photovoltaic systems," IEEE Trans. Power Electron., vol. 21, no. 6, pp. 1776–1782, Nov. 2006.
- H. Patel and V. Agarwal, "A single-stage single-phase transformer-less doubly grounded grid-connected PV interface," IEEE Trans. EnergyConvers., vol. 24, no. 1, pp. 93–101, Mar. 2009