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"Coupled Inductor based Single-Stage Boost Inverter"

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Abstract :- Renewable power systems as distributed generation units often experience big changes in the inverter input voltage due to fluctuations of energy resources. Often, a front-end boost converter is added to step up the dc voltage when the energy re- sources are at a weak point. However, when a very high boost gain is demanded, the duty cycle may come to its extreme, and large duty cycles causes serious reverse-recovery problems. This paper proposes a novel single-stage boost-type inverter with coupled inductor. By introducing impedance network, including coupled inductor, into the three-phase bridge inverter, and adjusting the previously forbidden shoot-through zero state, the converter can realize a high boost gain and output a stable ac voltage. The single-stage operation of the converter may lead to improved reli- ability and higher efficiency. Theoretical analysis, simulation, and experimental results are presented to verify good performance.

Key Words: ***single phase, boost, inverter, high gain, coupled inductor.***

1.INTRODUCTION

This presents a significant opportunity for distributed power generation (DG) systems using renewable energy resources, including wind turbines, photovoltaic (PV) generators, small hydro systems, and fuel cells. However, these DG units produce a wide range of voltages due to the fluctuation of energy resources and impose stringent requirements for the inverter topologies and controls. Usually, a boost-type dc–dc converter is added in the DG units to step up the dc voltage. This kind of topology, although simple may not be able to pro- vide enough dc voltage gain when the input is very low, even with an extreme duty cycle. Also, large duty cycle operation may result in serious reverse-recovery problems and increase the ratings of switching devices. Furthermore, the added converter may deteriorate system efficiency and increase system size, weight, and cost. On the other hand, the upper and lower devices of the same phase leg cannot be gated on simultaneously in conventional voltage source inverter (VSI). Otherwise, shoot-through problems would occur and destroy the switching devices. Dead time is always used in case of shoot-through events in bridge type converters, but it will cause waveform distortion. Though dead- time compensation technology, has been developed, it increases control complexity. So, it is desirable to have a single-stage high-gain boost inverter featuring no shoot through issues. Single-stage topologies, which integrate performance of each stage in a multistage power converter, are becoming the focus of research. Though they may cause increased control complexity, they may offer higher efficiency, reliability, and lower cost. It is observed that many single-stage voltage source and current source, inverters have been proposed. A Z-source inverter (ZSI) proposed in is able to overcome the problems in conventional VSI and conventional cur- rent source inverter. It can provide a wide range of obtainable voltage and has been applied to renewable power generation systems. However, this topology is complex and inductors and capacitors in the Z-network should have high consist. Moreover, only shoot- through zero state can be regulated when higher voltage gain is required. Widening shoot-through zero state will decrease modulation index and output voltage amplitude. Also, in order to completely avoid

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the unwanted operation modes, the input diode should be replaced by a switch which turns ON during all active states and traditional zero states. Four quasi-Z-source inverters derived from the conventional ZSI have been proposed in , whose basic principles are similar to those of conventional ZSI. Corresponding control methods and application conditions of conventional ZSI also fit for the qZSIs in theory. Anderson and Peng show some advantages of qZSIs over conventional ZSI, such as lower voltage/current stress of impedance network and lower switch voltage stress. Nevertheless, they do not overcome the limits of conventional ZSI described earlier.

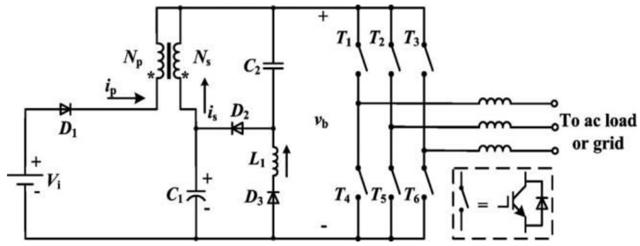

Fig. 1. Topology of single-stage boost inverter with coupled inductor.

2. Body of Paper

Objectives

- Main objective of project to design Coupled Inductor based Single-Stage Boost Inverter
- To avoids destroying devices during shoot-through zero states
- To reduce Total Harmonic Distortions in order to get sinusoidal output. To improved reliability.
- The single-stage boost inverter with cou- pled inductor is suitable for applications where the input voltage varies from a relative low level to a higher level continuously

Project Methodology

- Fig. 1 shows the general structure of the proposed single- stage boost inverter. It employs a unique impedance network to combine the three-phase inverter bridge with the power source. The impedance network does not introduce any switching de- vices and may lead to improved reliability, higher efficiency, and lower cost. To extend the operation range of the inverter, coupled inductor with a low leakage inductance is used. The dc source can be a battery, diode rectifier, fuel cell, or PV cell. To describe the operating principle and characteristics, this paper focuses on one application example of the single-stage boost inverter: a single-stage boost inverter for wind power generation. For wind power generation system, variable speed wind turbine is often adopted because it is known to provide more effective power tracking than fixed speed wind turbine ,presents the relationship between the generator power output and rotational speed relating to wind speed changes. Note that the output power of wind turbine may be at a low level under a weak wind condition. A front-end dc–dc boost converter is added to step up bus voltage especially.

Table.1.: Simulation parameters

Parameters	Value
Switching frequency(S_p)	50kHz
Inductor(L_1)	30 H
Inductor(L_2)	120 H
Coefficient of coupling	0.95
Output capacitor	30 F
Resistive load	26.45

(a)

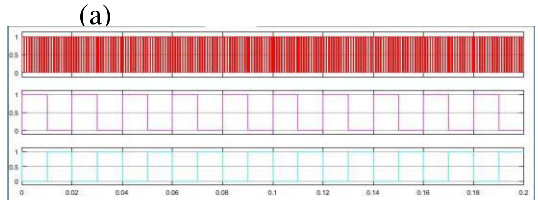

Fig.: Switching pulse.

(b)

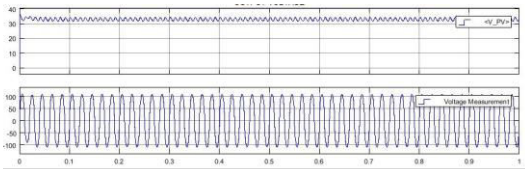

Fig.: Input and output current(i_{in} and i_{out}).

(c)

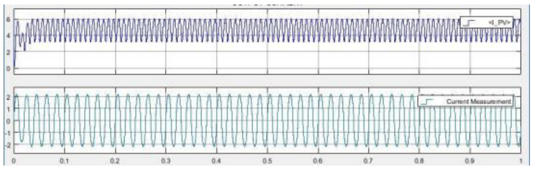

Fig. : Input and output voltage(V_{in}) and V_0).

Literature survey

[1] Y. Zhou and W. Huang, "Single-Stage Boost Inverter With Coupled Inductor," in IEEE Transactions on Power Electronics, vol. 27, no. 4, pp. 1885-1893, April 2012, doi: 10.1109/TPEL.2011.2165855.

Renewable power systems as distributed generation units often experience big changes in the inverter input voltage due to fluctuations of energy resources. Often, a front-end boost converter is added to step up the dc voltage when the energy resources are at a weak point. However, when a very high boost gain is demanded, the duty cycle may come to its extreme, and large duty cycles causes serious reverse-recovery problems. This paper proposes a novel single-stage boost-type inverter with coupled inductor. By introducing impedance network, including coupled inductor, into the three-phase bridge inverter, and adjusting the previously forbidden shoot-through zero state, the converter can realize a high boost gain and output a stable ac voltage. The single-stage operation of the converter may lead to improved reliability and higher efficiency. Theoretical analysis, simulation, and experimental results are presented to verify good performance.

[2] Y. Zhou, W. Huang, P. Zhao and J. Zhao, "A Transformerless Grid-Connected Photovoltaic System Based on the Coupled Inductor Single-Stage Boost Three-Phase Inverter," in IEEE Transactions on Power Electronics, vol. 29, no. 3, pp. 1041-1046, March 2014, doi: 10.1109/TPEL.2013.2274463.

This letter presents a modulation technique for the modified coupled-inductor single-stage boost inverter

(CL-SSBI)-based grid-connected photovoltaic (PV) system. This technique can reduce the system leakage current in a great deal and can meet the VDE0126-1-1 standard. To maintain the advantages of the impedance network, only a diode is added in the front of the original topology, to block the leakage current loop during the active vectors and open-zero vectors. On the other hand, the near-state pulse width modulation (NSPWM) technique is applied with one-leg shoot- through zero vectors in order to reduce the leakage current through the conduction path in the duration of changing from and to open-zero vectors. Simultaneously, the leakage current caused by other transitions can also be reduced due to the fact that the magnitude of common-mode voltages is reduced. Simulation results of the transformerless PV system are presented in two cases: modified CL-SSBI modulated by maximum constant boost (MCB) control method and NSPWM. Experimental results for both CL-SSBI topology modulated by the MCB control method and modified CL-SSBI topology modulated by NSPWM are also obtained to verify the accurateness of theoretical and simulation models..

[3] T. Sreekanth, N. L. Narasamma and M. K. Mishra, "A single stage high gain buck-boost inverter with coupled inductor," 2014 IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES), Mumbai, 2014, pp. 1-5, doi: 10.1109/PEDES.2014.7042042.

Output dc voltage from Fuel Cell (FC)/Photo Voltaics (PV) needs to be conditioned and converted into ac form before integrating to grid. Normally, two stage converters are used for this purpose. Two stage converters have several disadvantages like low efficiency, more number of components, big size, etc. especially when they are operated at low input voltages. In this paper, a coupled inductor based high performance, high gain, single-stage inverter topology, which can be used for grid connected FC/PV applications or stand-alone applications is proposed. In the proposed topology, dc- dc power conversion and dc-ac power conversion can be done in a single stage. The proposed topology has several features such as high gain, low cost and compact size. This topology suits well for low power applications. The principle of operation, steady state analysis of the proposed topology is presented in this paper. The steady state analysis is verified by a simulation, simulation results of the proposed converter for an ac load is presented.

[4] T. Sreekanth, N. L. Narasamma, M. K. Mishra and S. Augustine, "A single stage coupled inductor based high gain DC-AC buck-boost inverter for photovoltaic (PV) applications," 2015 IEEE 42nd Photovoltaic Specialist Conference (PVSC), New Orleans, LA, 2015, pp. 1-5, doi: 10.1109/PVSC.2015.7356269.

Normally, a two stage power conversion system is used to convert a low dc voltage to high amplitude ac voltage. These two stage power conversion systems are very bulky, more complex in control and less efficient, etc when they are used, especially for low input dc voltages. In this paper a high gain dc-ac inverter topology is presented, which can produce an instantaneous output voltage higher or lower than the input dc voltage without any intermediate power.

3. CONCLUSIONS

A single stage single phase couple inductor base boost inverter is presented. By deploying a coupled inductor the topology attains high voltage gain.

There is no issue of injurious effect of leakage current of coupled inductor as it is eliminated using a diode. This topology has less switching loss, compact size etc. Operation modes and circuit analysis is presented. The MATLAB/SIMULINK simulation solutions are also presented which approve the operation of the inverter.

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[4] T. Sreekanth, N. L. Narasamma, M. K. Mishra and S. Augustine, "A single stage coupled inductor based high gain DC-AC buck-boost inverter for photovoltaic (PV) applications," 2015 IEEE 42nd Photovoltaic Specialist Conference (PVSC), New Orleans, LA, 2015, pp. 1-5, doi: 10.1109/PVSC.2015.7356269.