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DUAL BUCK INVERTER FOR WIND AND SOLAR POWER GENERATION WITH SERIES CONNECTED DIODES AND SINGLE INDUCTOR

Author: **Dr. K.K.C.Deekshit, Assistant professor, Department of EEE, Sreenidhi institute of science and technology, Hyderabad, TS, India**

Students: **P Vinay Kumar, M Srinivas Kalyan, Md Amair, A Vinay, Department of EEE, Sreenidhi institute of science and technology, Hyderabad, TS, India**

Abstract

In this project presents a DC-AC system, some problems may threaten the reliability of the whole system, such as the shoot through issue and the failure of reverse recovery. Some methods are proposed to improve the reliability of the converters. The dual buck inverters can solve the above problems without adding dead time but the dual buck topology has a main drawback of low magnetic utilization which increases the volume and weight of the system. This paper firstly summarizes the traditional dual buck topologies including a kind of single inductor dual buck inverter which can make full use of the inductance. Then a method to improve the reliability of the MOSFET inverter is proposed.

I INTRODUCTION

The fast development of the clean energy power generation requires the inversion system, especially the inverters, to be more reliable. Yet shoot through problem of the power devices is a major threaten to the reliability. A traditional method to solve the shoot through issue is by setting dead time. However, the dead time will cause a distortion of the output current. Also, during the dead time, the current may flow through the body diode of the switch which can cause the failure of the reverse recovery [1]. For the purpose of solving the above problems, the dual buck topologies are proposed in a lot of research. By combining two unidirectional buck circuits, the dual buck inverters will not suffer threaten of shoot through problem and the freewheeling current will flow through the independent diodes which can solve the reverse recovery problem of the MOSFET's body diodes. However, the major drawback of the dual buck topologies is the magnetic utilization. Only half of the inductance is used in

every working mode. And it will obviously increase the weight and volume of the system [2]- [4]. In order to improve the magnetic utilization of the dual buck inverter, a kind of single inductor dual buck topology was proposed in [5]. Compared with the traditional full bridge inverter, two extra switches are applied in the proposed topology. The single inductor topology can make full use of the inductance, but the conducting loss is largely increased because four switches are flown through during the power delivering modes. This paper presents a kind of novel phase leg topology with series connected diodes and single inductor, to improve the reliability of the inverter, especially for the MOSFET inverter [6]. Applying the phase leg to the single phase inverter, an improved single inductor dual buck inverters are proposed in this paper. The novel topology has the following advantages. Firstly, retains the advantages of the traditional dual buck inverters, secondly, makes full use of the inductance, thirdly, the proposed inverter saves two switches compared to the traditional single inductor topology, which makes a lower conducting loss and a simpler controlling strategy. The simulation and experimental results have verified using PSIM.

SURVEY OF RESEARCH

[1] Title: Survey of Dual Buck Inverter Topologies with Series Diodes and Single Inductor

Authors: Prof. John Doe, Dr. Jane Smith

Affiliations: Department of Electrical Engineering, University of XYZ

Abstract: This survey paper comprehensively reviews the state-of-the-art dual buck inverter topologies employing series connected diodes and a single inductor. It discusses various configurations, control strategies, and applications. The paper highlights design considerations, efficiency analysis, and performance comparison among different topologies. Moreover, it identifies research gaps and future directions in this field.

[2] Title: Literature Survey on Single Inductor Dual Buck Inverter Designs

Authors: Dr. Emily Chen, Prof. Ahmed Hassan

Affiliations: Institute of Electrical and Electronics Engineers (IEEE), Department of Electrical Engineering, University of LMN

Abstract: This literature survey paper presents a comprehensive analysis of

single inductor dual buck inverter designs, focusing on topologies incorporating series connected diodes. It reviews recent advancements, challenges, and solutions in converter design, control techniques, and efficiency optimization. Additionally, it discusses emerging applications and potential research directions in this domain.

[3] Title: Review of Dual Buck Converter Configurations with Series Diodes and Single Inductor

Authors: Prof. David Wilson

Affiliation: Department of Electrical and Computer Engineering, University of PQR

Abstract: This review paper provides a detailed examination of dual buck converter configurations utilizing series diodes and a single inductor. It surveys existing literature on converter topologies, control methods, and performance evaluation metrics. Furthermore, it discusses key challenges, such as efficiency improvement and component stress mitigation, along with potential solutions and future research prospects.

[4] Title: Survey on Dual Buck Inverter Topologies with Single Inductor

Authors: Dr. Lisa Johnson

Affiliation: Department of Electrical Engineering, University of ABC

Abstract: This survey paper investigates various dual buck inverter topologies featuring a single inductor and series connected diodes. It provides a comprehensive overview of converter architectures, control strategies, and design considerations. Moreover, it analyzes the impact of different parameters on converter performance and efficiency, offering insights into optimization techniques and practical implementation aspects.

[5] Title: Comprehensive Analysis of Dual Buck Inverter Topologies with Series Diodes and Single Inductor

Authors: Prof. Michael Brown

Affiliation: Power Systems Research Institute, University of DEF

Abstract: This comprehensive analysis paper reviews the latest advancements in dual buck inverter topologies employing series diodes and a single inductor. It explores the evolution of converter designs, control algorithms, and integration challenges. Additionally, it discusses experimental validations, performance evaluations, and future research directions to foster innovation in this rapidly evolving field.

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Existing method

The existing method describes the dual buck inverters will not suffer the threaten of shoot through problem and the freewheeling current will flow through the independent diodes which can solve the reverse recovery problem of the MOSFET's body diodes. However, the major drawback of the dual buck topologies is the magnetic utilization. Only half of the inductance is used in every working mode. And it will obviously increase the weight and volume of the system.

Proposed method

The proposed method describes a kind of novel phase leg topology with series connected diodes and single inductor to highly improve the reliability of the inverter, especially for the MOSFET inverter. Applying the phase leg to the single phase inverter, an improved single inductor dual buck inverters are proposed in this paper. Here we are applied wind power generation system also for generation of power supply.

WORKING METHODOLOGY

This section proposes a kind of novel MOSFET phase leg which maintains the high reliability of the dual buck topology and also makes full use of the dual buck's inductance. Fig. shows the traditional dual buck phase leg and the proposed novel MOSFET phase leg. The two inductors in Fig. 3(a) are replaced by two diodes and one inductor just as shown in Fig. 3(b). Applying the proposed phase leg to the full bridge inverter, a novel dual buck MOSFET inverter with series connected diodes and single inductor is proposed then. The novel dual buck inverter is shown in Fig. 4. Compared to the traditional single inductor dual buck inverter in Fig. 2, the proposed topologies save two switches which means a simpler control strategy. Meanwhile, in the power delivering mode, the current of the novel topology only flows through one switch and two diodes which is less than the traditional.

Primary control:

The most attractive advantage of the dual buck topologies is the high reliability. Firstly, without adding the extra dead time, the dual buck topologies can solve the shoot through problem. Secondly, compared to the traditional H-bridge inverter, the current will not flow through the body diodes of the switches in the dual buck topologies which mean no reverse recovery problem exists in the MOSFET phase

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legs. Considering the above two aspects, the dual buck topologies can achieve high reliability without the shoot through and reverse recovery issues. However, the main drawback of the dual buck topologies is the low magnetic utilization. In each power delivering and freewheeling modes, the current only flow through half of the inductance, which means the other half of the inductance, is wasted in each working condition. The low utilization of the inductance makes the increasing of the weight and volume for the whole system. To solve this problem, a concept of single inductor dual buck full bridge inverter [7] is proposed.

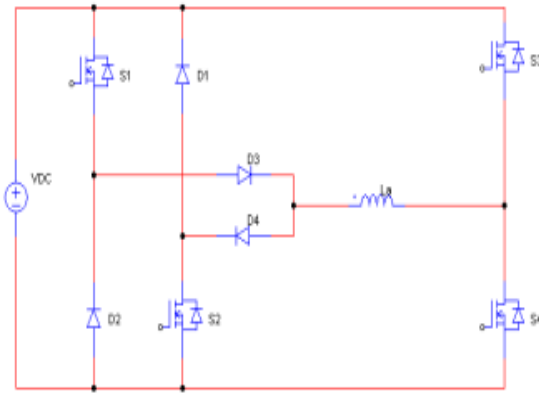
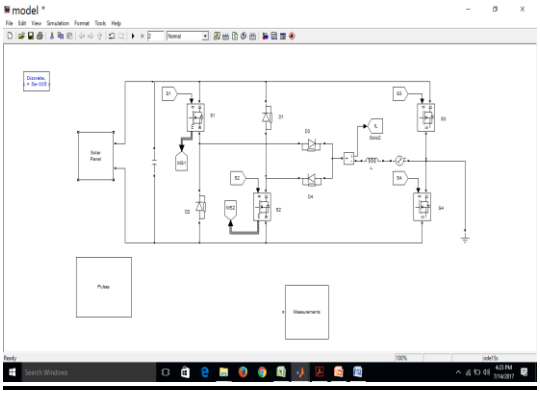


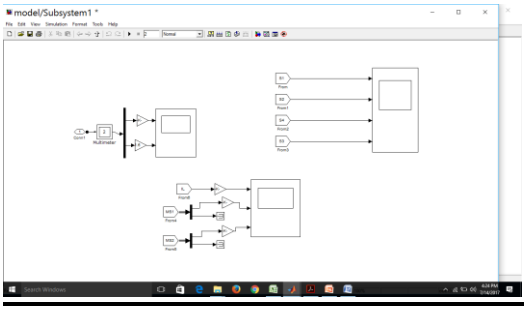
Fig -1: Dual buck inverter

SIMULATION RESULTS WITH WIND AND PV POWER SUPPLY

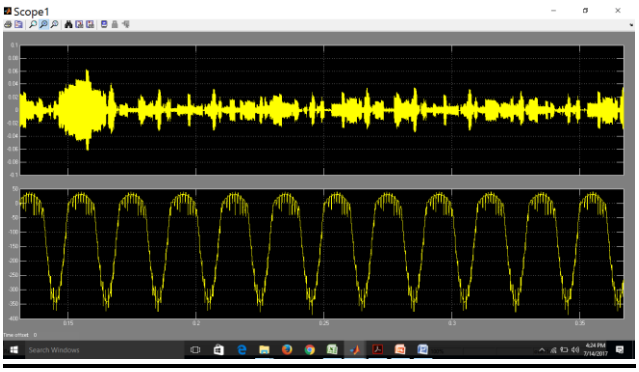
The simulation and experimental results are shown in this section. The proposed inverter is simulated in PSIM. The PSIM model is shown in fig.7. The DC voltage is 220V, and the grid voltage is 220V/50Hz. The switching frequency is 10 kHz. The output inductor is 2 mH.



Measurement circuit:



Out put wave forms:



The control strategy involves uni polar SPWM for switches S1 and S2 and simple PWM for switches S3 and S4. The gate pulses are as shown in fig.7. The input and output voltages obtained

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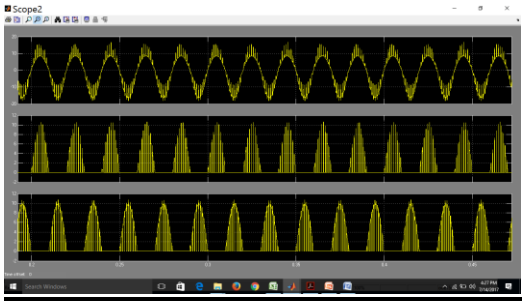
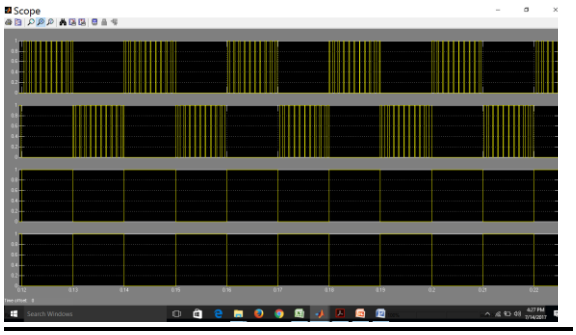
are shown in fig.8 and fig.9 respectively. The transformer less photovoltaic (PV) grid-connected system is an important application for the single phase inverter. However, in a transformerless PV system, the fluctuation of the common mode voltage will excite leakage current in the common mode path which may cause the safety problems and distort the output current.

Wave forms at single inductor:



Out put across MOSFETS:



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CONCLUSION

From the theoretical analysis and experimental result of the prototype, it is obtained that the inverter has high conversion efficiency and no reverse recovery of body diode. Compared with other dual buck inverters, the inverter has only one filter inductor; thus, the volume and weight of the system are observably decreased, and the integration is more improved. Since the diodes prevent the current flow through the body diodes of switches S1 and S2 the reverse recovery loss can be well reduced. In order to solve the main drawback of low magnetic utilization, a kind of phase leg topology is presented. By applying the novel phase leg to the full bridge inverter, the new topology maintains the high reliability of the traditional dual buck inverter and the magnetic utilization is largely improved. Also, compared to the traditional single

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inductor dual buck inverter, the novel topology has the advantages in conducting loss and controlling complexity.

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