Design and simulation of a novel Dual Buck Inverter for enhancing the performance of Series Connected Diodes and Inductor

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ABSTRACT:

This dual buck converters mainly suffering with magnetizing utilization, offset, shot and ripple problems, these problems are accomplished by coupling the inductors of two independent buck converters. The input voltage is split across the dual buck converter and the midpoint is balanced by coupling the inductors and switching the two switches at the same time. The inductors are wound on a single core, with the windings magnetically coupled, to form a new coupled inductor. A low cost, multiple output buck converter is provided using a single inductor, a single pulse width modulator integrated circuit, and two MOSFETs plus one additional MOSFET and capacitor for each voltage output. A kind of novel dual buck inverter with series connected diodes and single inductor is introduced. The novel inverter retains the dual buck topologies' advantage of high reliability and can make full use of the inductance. In order to improve the magnetic utilization of the dual buck inverter, a kind of single inductor dual buck topology was proposed in. Compared with the traditional full bridge inverter, two extra switches are applied in the proposed topology. 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. Proposed dual buck converter by using fuzzy control strategy employed best simulation results compare to traditional method.

Key Words: Inverter, MOSFET, Fuzzy Control.

I. Introduction :

Present fast rapid growth is going in clean energy power generation. It requires power electronics conversion system, especially those are inverters, and more reliable. But it is not reliable because of these problems, yet shoot through problem of the power devices is a Major threaten to the reliability. As is known, One of the famous traditional method to solve this problem is to solve the shoot through issue is by setting dead time. This dead time may 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].

Today's world Electric vehicles are attracting more and more attention due to increasing concerns on energy crisis and Environmental protection. DC/DC converters are mainly used in design of hybrid vehicles and electric vehicles. Their types are low power and high power. Low power bidirectional DC/DC converter connects the high voltage dc-link with a low voltage battery used to supply low power loads and high power bidirectional DC/DC converter used to connect the main energy storage unit with the electric traction drive system. In vehicle application these converters helps to charge LV battery during normal operation and also assist HV bus/battery when needed. For the purpose of solving the above problems, a lot of research work is going in dual buck converters circuits. This Shoot problem mainly overcome by adding two unidirectional buck circuits, 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 main drawback of this dual buck topologies is 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].

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.

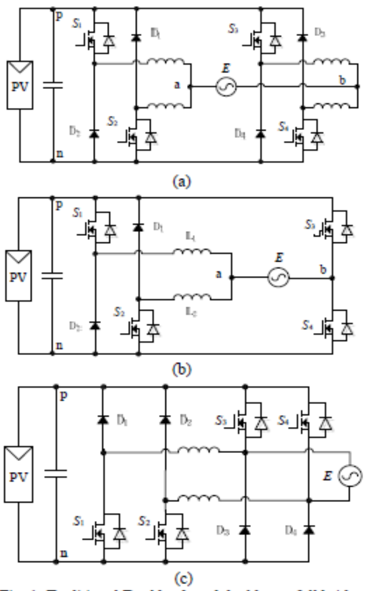


Fig. 1. Traditional Dual buck and dual boost full bridge inverters.

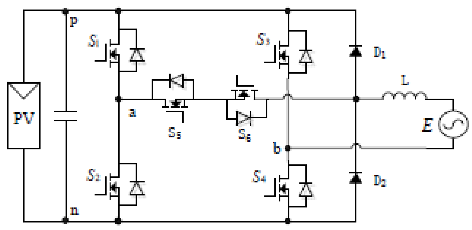
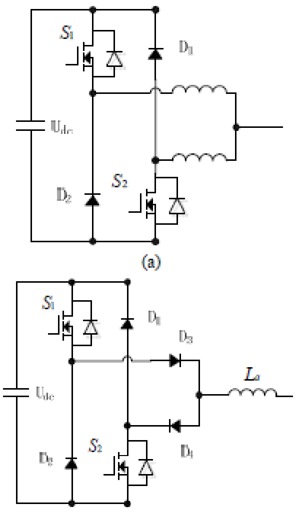


Fig. 2. Traditional Dual buck full bridge inverter with single inductor.



(b)
Fig. 3. (a)Traditional dual buck phase leg (b) proposed dual buck phase legs with series connected diodes and single inductor.

II. Traditional Method:

Fig. 1 shows the traditional dual buck and dual boost inverters [7]-[8]. 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 means no reverse recovery problem exists in the MOSFET phase 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 [5] is proposed. Fig. 2 shows the single inductor topology. The novel topology includes six switches and two diodes. Comparing to the traditional dual buck full bridge inverter, the single inductor topology can save half of the inductance. And the novel topology retains the original advantages of high reliability. Also, there is no need to add the dead time in the high frequency unipolar switching strategy. The inductance can be fully utilized in the single inductor inverter. However, a high level of conduction loss is the main drawback of the novel topology. During the power delivering mode, the current flows through four switches which is a lot more than the traditional full bridge inverters. Besides, compared to the traditional H bridge inverters, the extra two switches make controlling strategy more complex. And in the dual buck single inductor inverter, the current will flow through the body diodes of the series MOSFET switches which can cause the problem of reverse recovery.

III. Proposed Method:

To solve the problem of traditional H-bridge inverter, including the shoot through issue and the reverse recovery of the MOSFET, a kind of dual buck inverter with series connected diodes and single inductor is proposed in this paper. The newly proposed topology retains the advantage of traditional dual buck inverter and also solve the problem of low magnetic utilization. Also, the proposed topologies will not invite extra switches which means a simpler controlling strategy compared to the traditional dual buck single inductor full bridge inverter in [5].

The traditional method problems greatly overcome by using fuzzy control strategy, it is Control the operation of Dual buck converters circuit with fuzzy control strategy. The traditional approach to building system controllers requires a prior model of the system. The quality of the model, that is, loss of precision from linearization and/or uncertainties in the system's parameters negatively influences the quality of the resulting control. At the same time, methods of soft computing such as fuzzy logic possess non-linear mapping capabilities, do not require an analytical model and can deal with uncertainties in the system's parameters. Based on the nature of fuzzy human thinking, it is mentioned as the "fuzzy logic"

e(pu) / ce (pu)	NB	NM	NS	ZE	PS	PM	PB
NB	NB	NB	NB	NM	NS	NVS	ZE
NM	NB	NB	NM	NS	NVS	ZE	PVS
NS	NB	NM	NS	NVS	ZE	PVS	PS
Z	NM	NS	NVS	ZE	PVS	PS	PM
PS	NS	NVS	ZE	PVS	PS	PM	PB
PM	NVS	ZE	PVS	PS	PM	PB	PB
PB	ZE	PVS	PS	PM	PB	PB	PB

Table.1. Graphical presentation of the rules

IV. Simulation Results:

The MATLAB Simulation block diagram of dual buck converters operated by using fuzzy controllers is shown in fig.4

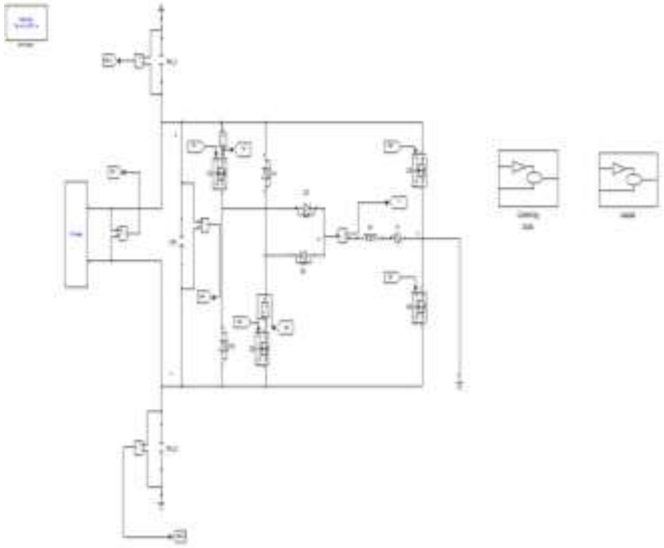


Fig.4 Simlink Model of the proposed system

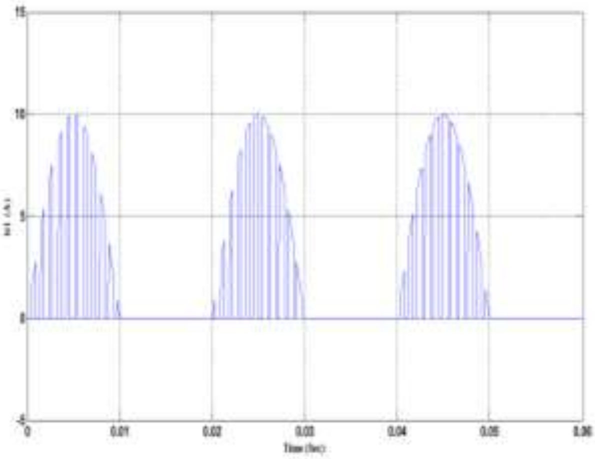


Fig.7.

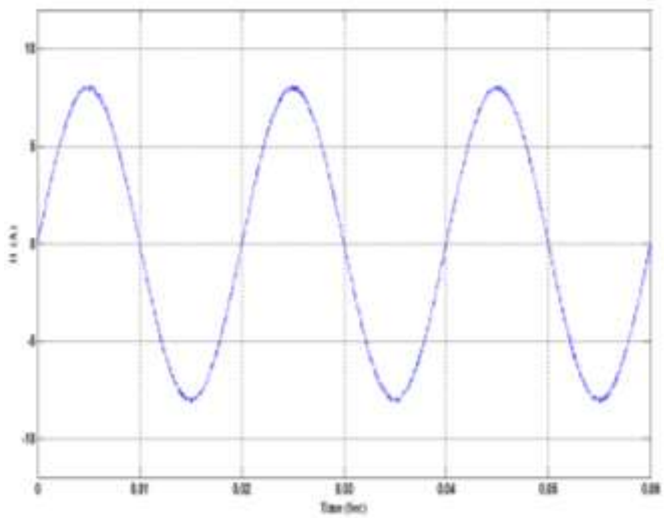


Fig.5.

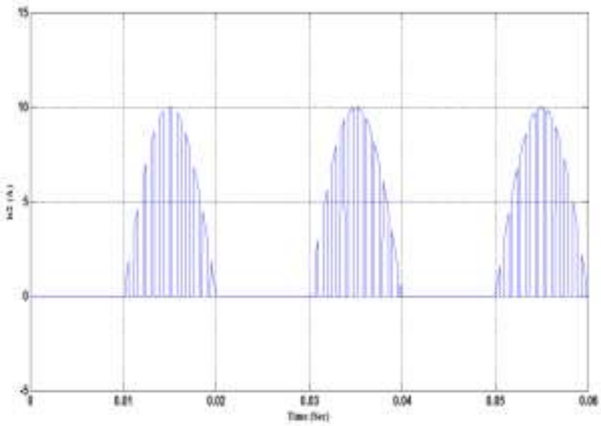


Fig.8.9. The filtering current and the switching current of the proposed inverter

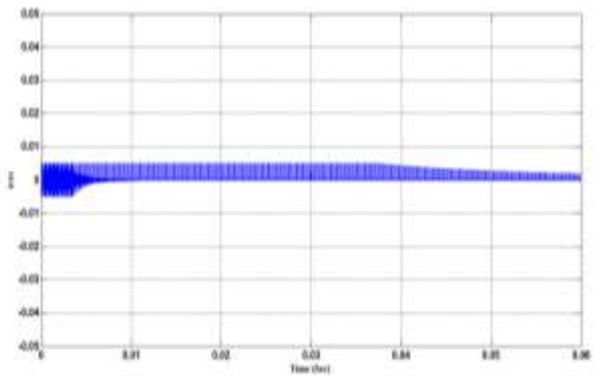
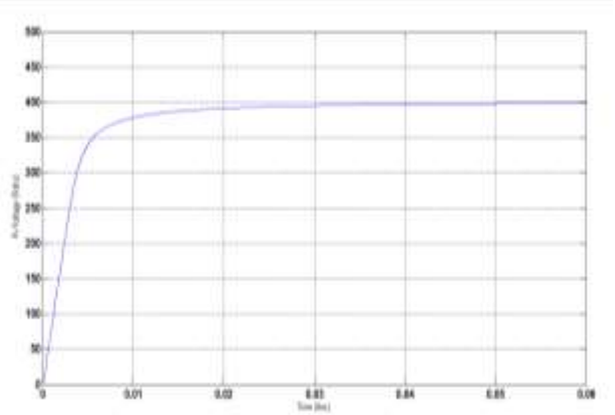


Fig.6.



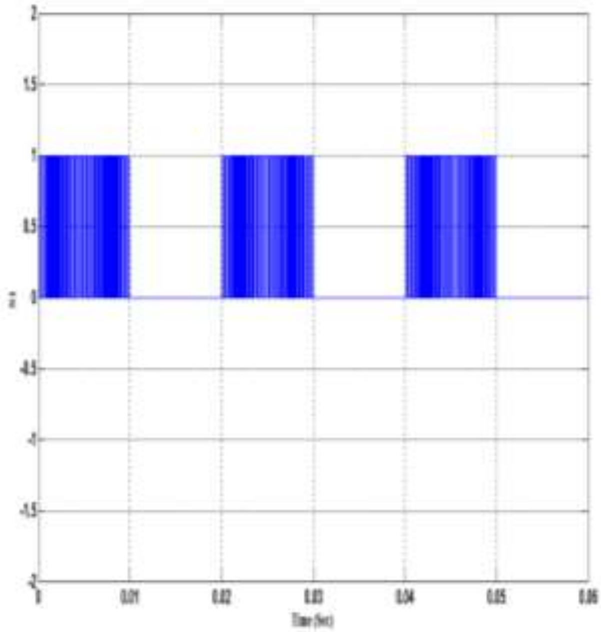


Fig .10

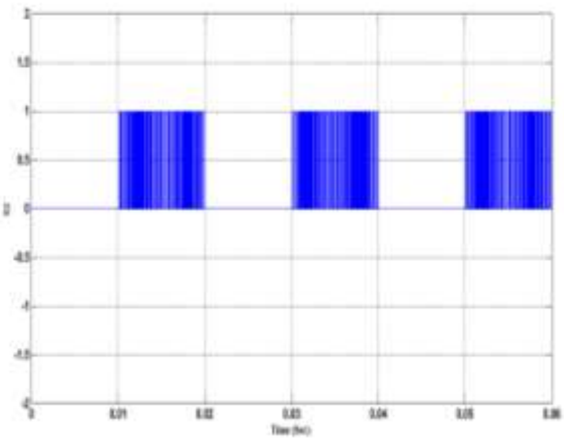
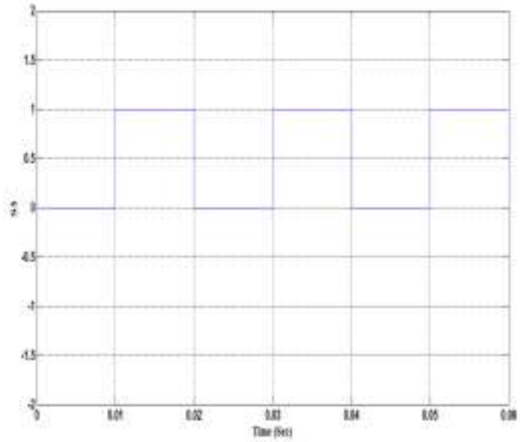


Fig.11.



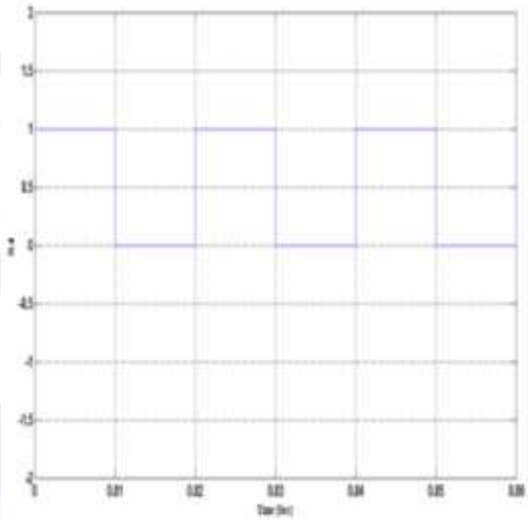


Fig.12 and Fig. 13 (fig 10, 11, 12, 13) represents the simulated switching signals of the proposed dual buck inverters

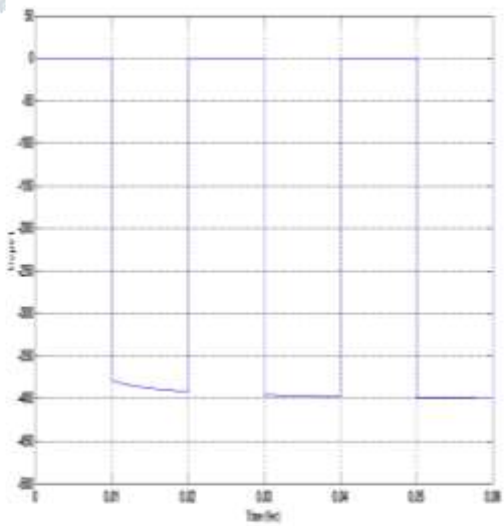


Fig. 14. The simulated common mode waveforms of the proposed dual buck inverters

V. Conclusion:

In this paper discussed about dual buck topologies operating with fuzzy control strategy. The advantages and disadvantages of the dual buck inverters are specifically analyzed. In order to solve the main drawback of low magnetic utilization, a kind of phase leg topology is proposed. 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 inductor dual buck inverter, the novel topology has the advantages in conducting loss and controlling complexity.

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