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# Non Isolated Dual Inductor Boost Converter With Auxiliary Transformer

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**Abstract**

**This paper presents the simulation of non isolated dual inductor boost converter with auxiliary transformer. This converter is capable of giving higher output voltage and can achieve constant frequency control using auxiliary transformer. The converter's regulation range is extended by employing an auxiliary transformer to couple the current path of dual boost inductor. This converter shows variation from low input voltage to high output voltage. This model is simulated in MATLAB.**

**Keywords:** Dual inductor fed DC/DC boost converter, auxiliary transformer,voltage doubler.

## 1.INTRODUCTION

DC-DC converters are widely used electronic components that convert DC power from one voltage level to another while regulating the output voltage. The output provides a voltage to a current. DC-DC converters are useful for generating output voltages that are either higher or lower than the input voltage.A step-up (or boost) converter produces an output voltage higher than the input voltage.

The boost converter topology has been extensively used in various AC/DC and DC/DC applications. In fact, the front end of today's ac/dc power supplies with power factor correction is almost exclusively implemented with boost topology.

Converters with high frequency transformers have been commonly used for many years. However, when there is no need to use galvanic isolation between the input and the output, non-isolated boost DC/DC converters are the recommended solution.The performance of the boost converter can be improved by implementing a boost converter with multiple switches and/or multiple boost inductors. So far, a number of isolated and non-isolated multiple switch and/or multiple- inductor topologies have been proposed, analyzed, and evaluated. The interleaved topology is often used in high-power PFC applications to eliminate reverse-recovery losses of the boost rectifier by operating the two boost converters at the boundary of the continuous-conduction mode (CCM) and discontinuous conduction mode (DCM) so that the boost switches are turned on When the current through the corresponding boost rectifier is zero. Since in high-power applications the input current (boost-inductor current) ripple of a single DCM boost converter is very high, the switching instances of the two boost switches are interleaved, i.e., phase shifted for180° degrees. With the interleaving, the input current ripple is reduced and, consequently, the size of the input filter is minimized. To achieve the operation at the CCM/DCM boundary under varying line and load current conditions, the interleaved boost converter requires a variable switching frequency control, Which is often perceived as a major drawback of the circuit. In addition, the implementation of the interleaved variable-frequency control is relatively complex.The dual-inductor boost converter exhibits benefits in high power applications: high input current is split between two inductors, thus reducing I2R power loss in both copper windings and primary switches.

The two-inductor, two-switch circuit shown in Fig. that is described and analyzed in exhibits some interesting properties. Specifically, the main feature of this circuit is that the voltage stress of each switch is one half the voltage stress of the switches in the single inductor implementation in In addition, the input current is distributed evenly through the two boost inductors so that the current ripple in the output capacitor is smaller than in the single-inductor implementation. However, the major limitation of the two-inductor circuit in Fig.1Is its inability to regulate the load in wide range with constant frequency control.

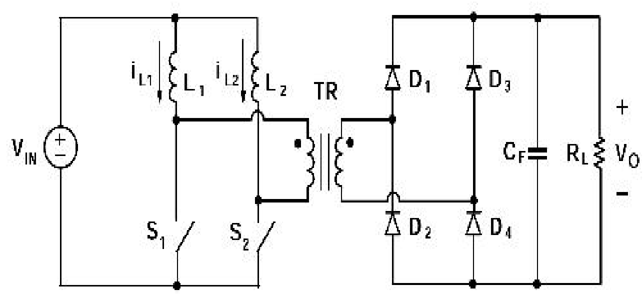


Fig.1 Conventional two-inductor boost converter.

- **TWO INDUCTOR BOOST CONVERTER WITHOUT AUXILIARY TRANSFORMER**

The fig.2(a) Shown below is two inductor boost converter without auxiliary transformer. The waveform for this fig.2(a) is shown in fig.2(b). As can be seen from fig above because of absence of the coupling between the current flowing in the inductor L1 & L2, currents IL1 and IL2 are not the same. Namely, current IL1 increases during entire time switch S1 is on and decreases during entire off time of switch S1. Similarly,current IL2 increases during entire time switch S2 is on and decreases during its entire off time. As a result, even when duty cycle D of converter in fig. below is reduced to zero, the energy is still stored in inductors because switch S1 and S2 are on for a half of switching period Ts. To reduced the stored energy and extend the load regulation range ,it is necessary to shorten the conduction time of switches. This can be accomplished by switching frequency. It should be noted that because of absence of auxiliary transformer the voltage conversion ratio of circuit in fig2(a) is only one half of conversion ratio of circuit. It also require a variable frequency control to maintain output regulation in a wide range.

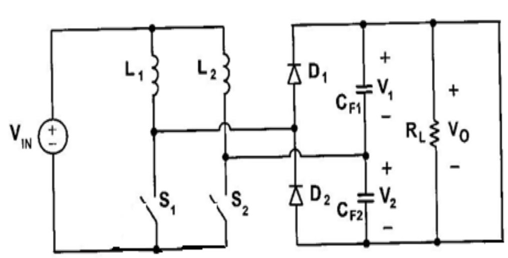


Fig.2(a) Two inductor boost converter without auxiliary transformer

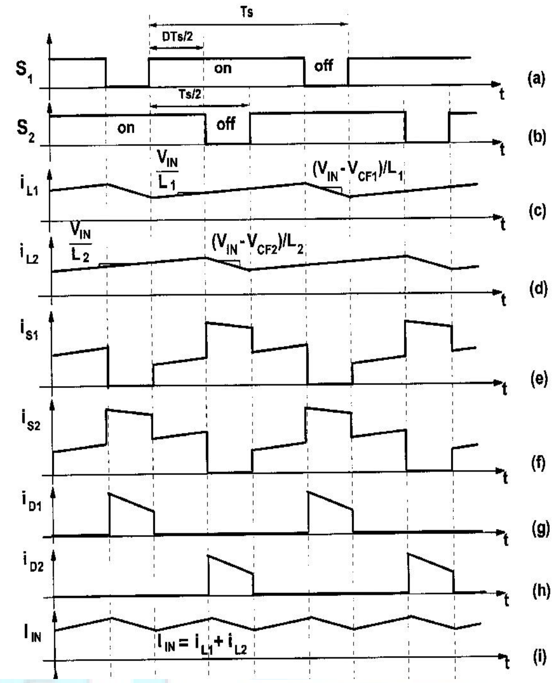


Fig.2(b) waveform of two inductor boost converter without auxiliary transformer

## 3. NON ISOLATED DUAL INDUCTOR BOOST CONVERTER WITH AUXILIARY TRANSFORMER

The non isolated dual inductor boost converter considered in this paper consists of a two inductor two switch boost converter topology that can achieve output voltage regulation from full load to no load in a wide input voltage range using constant frequency control. This employs an auxiliary transformer with a unity turns ratio to couple the current paths of the two boost inductors so that both inductors conduct identical currents. Due to this current mirror effect of the auxiliary transformer, no energy is stored in the inductors when there is no overlapping of conduction times of the two switches, i.e., when D=0. This auxiliary transformer approach can be applied to isolated or non isolated two inductor two switch topologies with any type of output rectifier.

The converter's unique property to simultaneously charge and discharge both boost inductors due to the coupling of inductor currents through the auxiliary transformer, the converter can maintain the regulation of the output voltage with a constant frequency control in a wide range of the load current.

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## 4. SIMULATION RESULTS

The non isolated dual inductor boost converter with auxiliary transformer circuit is shown in fig 4(a).

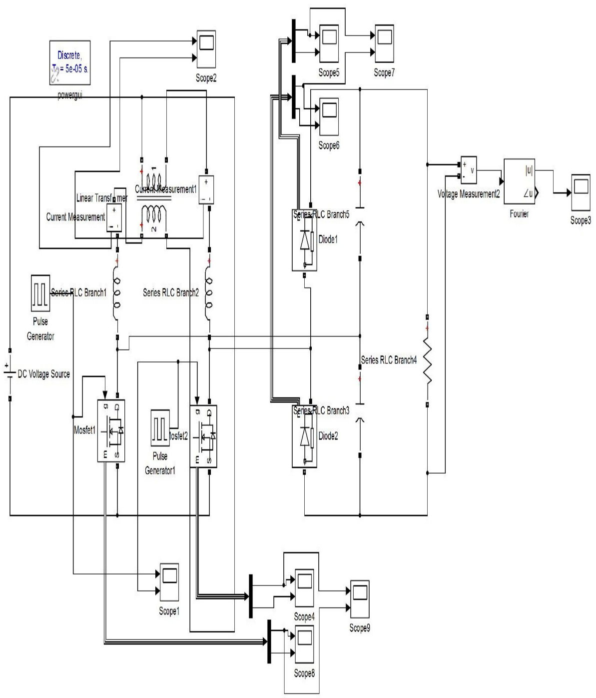


Fig.4 (a) Non isolated dual inductor boost converter with auxiliary transformer

The input side of the circuit consists of two switches S1 an S2, two boost inductors L1 and L2, and auxiliary transformer ATR. To maximize the voltage gain of the converter, the output side of the circuit is configured as a voltage doubler rectifier that consists of boost rectifiers D1 and D2 and output filter capacitors CF1 and CF2 connected across load RL. In the simplified circuit, auxiliary transformer ATR is modeled as an ideal transformer with turns ratio nATR=1 by assuming that its magnetizing inductance is high so that it can be neglected. In addition, it is assumed that filter capacitors CF1 and CF2 are large enough so that the voltage ripple across them is small compared to their dc voltages. Finally, in this analysis it is also assumed that all semiconductor components are ideal, i.e., that they represent zero impedances while in the on state and infinite impedances while in the off state.

The operation of the circuit can be explained through various time periods. During mode 1, the switch S1 is closed. This makes the circuit complete, causing the flow of current. Therefore the current through the inductor L2 forward biases the diode D2 and the switch S2 remains open, thereby the inductor discharges the energy stored in it.

During mode 2 both the switches S1 and S2 are turned ON. The current flow through the inductors L1 and L2 are increases at an equal rate. The capacitors C1 and C2 discharge their stored energy because the diodesD1 and D2 are reverse biased. As a result, the input part of the circuit is decoupled from the output part. During the mode 3, the switch S1 is turned ON and the inductor which is charged in mode 2 discharges through capacitor C1. During mode 4, the circuit repeats the operation as in mode 2.

Different waveforms associated with the circuit are given below: fig. 4(b) shows the input voltage waveform of non isolated dual inductor boost converter with auxiliary transformer circuit.

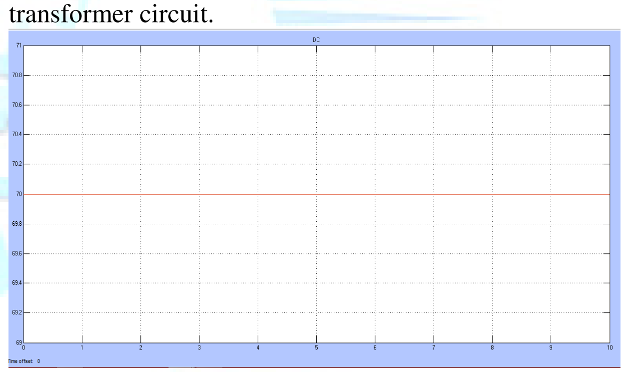


Fig.4(b) DC input voltage

The pulse and inductor current waveforms are presented in Figure 4.(c) and 4(d).. The current iL1 in inductor L1 increases during the entire on time of switch S1. Similarly, current iL2 in inductor L2 increases during the on time of switch S2 and decreases during its off time.

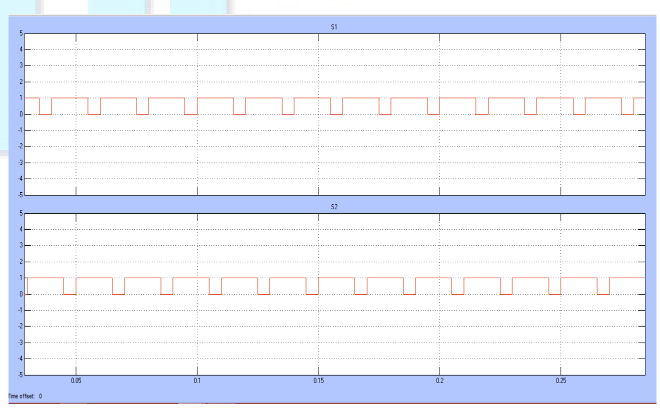


Fig.4(c) Switching pulse S1 & S2

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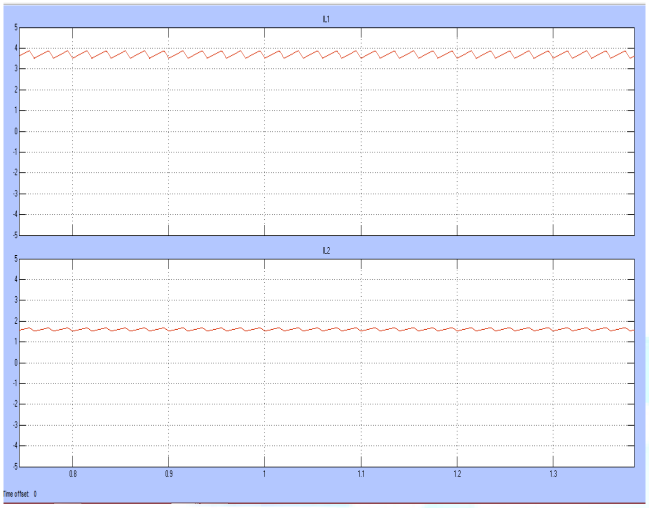

Fig..4(d) inductor current L1 &L2

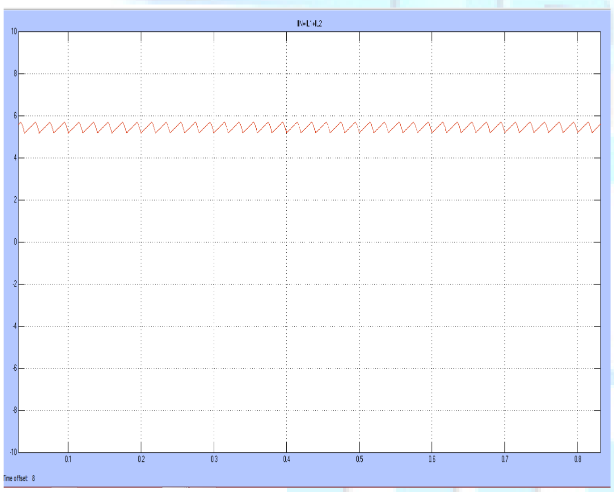

Fig.4(e) Sum of inductor current L1 & L2 (IL1+IL2)

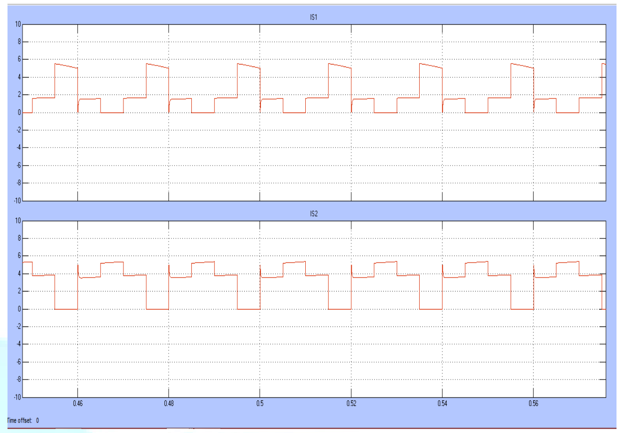

Fig.4(f) Switching current IS1 & IS2

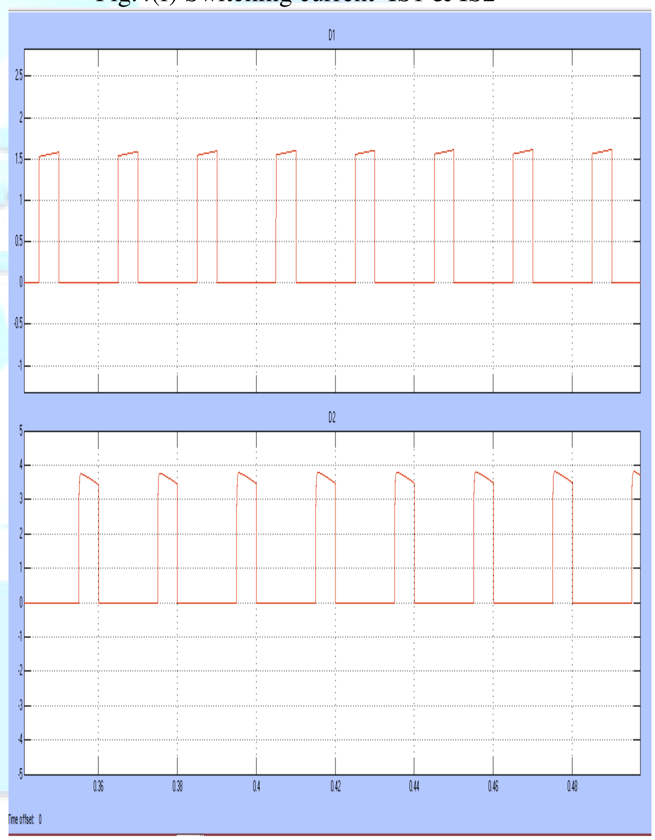

Fig.4(g) Diode current ID1 & ID2

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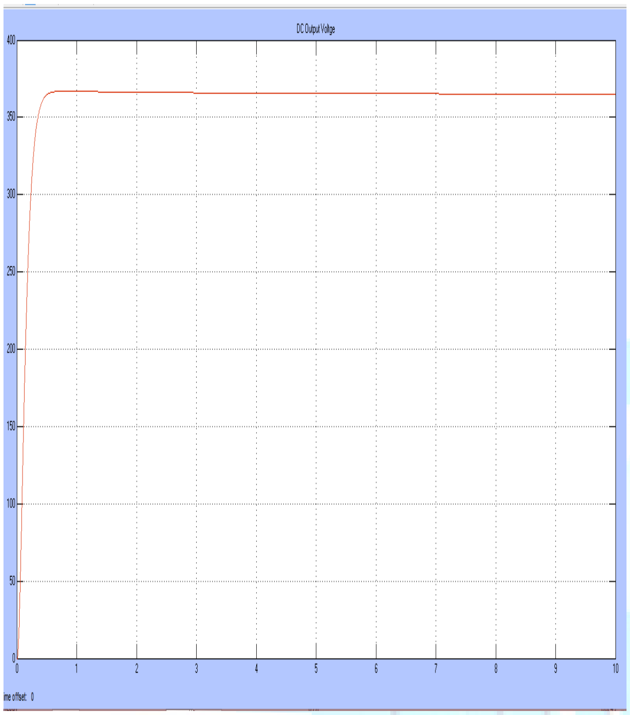


Fig.4(h) DC output voltage

It can be seen that the DC output is free from ripple. The DC voltage settles at 362V. The variation of output with the input is shown in Fig.4(h) Output voltage increases with the increase in the input voltage.

## 5. CONCLUSION

A non isolated dual inductor boost converter with auxiliary transformer is simulated using MATLAB SIMULINK and results are presented. The proposed converter consist of an auxiliary transformer that couples the current path of dual boost inductor which extends the converter's regulation range.The proposed converter operates from a 70V battery input and deliver up to 1.2A at a 362-V output. They provide better utilization of switches and they require smaller passive components.

A non isolated implementation with a voltage-doubler rectifier exhibits a voltage gain that is four-five times of the corresponding gain of the conventional non isolated boost converter.The non isolated dual inductor boost converter with an auxiliary transformer are suitable for applications that require a high input-to-output voltage conversion ratio. This converter can also regulate the load in a wide range with constant frequency control.

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