International Journal of Emerging Technology in Computer Science & Electronics (IJETCSE)
ISSN: 0976-1353 Volume 8 Issue 1 –APRIL 2014.

Design and Hardware implementation of Two Phase Coupled InductorInterleaved Boost Converter with Low Ripple Circuit

S.Tony Richard[1], R.G.Nirmala,M.E[2]

*(M.E Power Electronics and Drives, St. Joseph's College of Engineering, India)
** (Assistant Professor, Department of EEE, St. Joseph's College of Engineering, India)

***Abstract*—This paper presents an design and modeling of coupled inductor interleaved boost converter with low ripple circuit. Based on the conventional converter, two capacitors, two coupled inductors, and two inductors are added as low ripple circuit in the proposed converter.Here proposed converter is used to reduce the input,output current ripple and also output voltage ripple in higher range.Here for implementation purpose 36v input voltage and 50v output voltage dc-dc converter operating at 100khz switching frequency is constructed.The output is implemented and verified by using MATLAB Simulink.**

***IndexTerms*—Interleaved boost converter,Coupled inductor,dc-dc converter**

1. INTRODUCTION

.

Nowadays, coupled inductor interleaved boost converter is used in most of the photovoltaic application, electric vehicles, power factor correction. Here input and output current ripple is a major problem in dc-dc converter. The input current ripple of the dc-dc converter is inversely proportional to input inductor current value. So the larger inductor value results in low ripple, on other increasing the inductor value the total weight of the converter gets increased.

The proposed converter aims that without increasing the inductor value the ripple should be reduced. So that interleaving of the converter technique is used. By using interleaving technique the ripple is reduced but the weight of the converter is not reduced. So that the new technique called coupled inductor interleaved boost converter technique is used.Here the ripple is reduced than interleaving technique and the weight of the converter is reduced since the core is shared, and inductor was coiled in single core. However, the leakage inductance of the coupled inductor increases the current stress of the output diode.The soft switching technique is the solution for this type of the problem but however, the control strategy of this circuit is too complex and not cost-effective.

In order to overcome the disadvantage of conventional converters, the new topology called coupled inductor interleaved boost converter with LC filter is developed. This converter uses two coupled inductor and two LC filter connected series to the coupled inductor. Here the LC filter is used to eliminate di / dt and gives ripple free input and output current

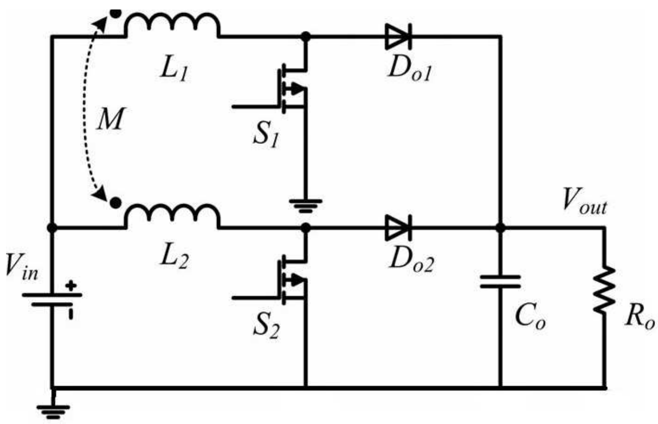


Fig.1 Conventional coupled inductor interleaved boost converter

II. COUPLED INDUCTOR INTERLEAVED BOOST CONVERTER WITH LOW RIPPLE CIRCUITAND ITS OPERATING PRINCIPLE

The coupled inductor interleaved boost converter with reduced ripple circuit is shown in Fig. 4. The four stages of the proposed converter in one operational period can be simplified into two typical stages and the corresponding equivalent circuits for each operational stage are shown in Fig. 3,4.

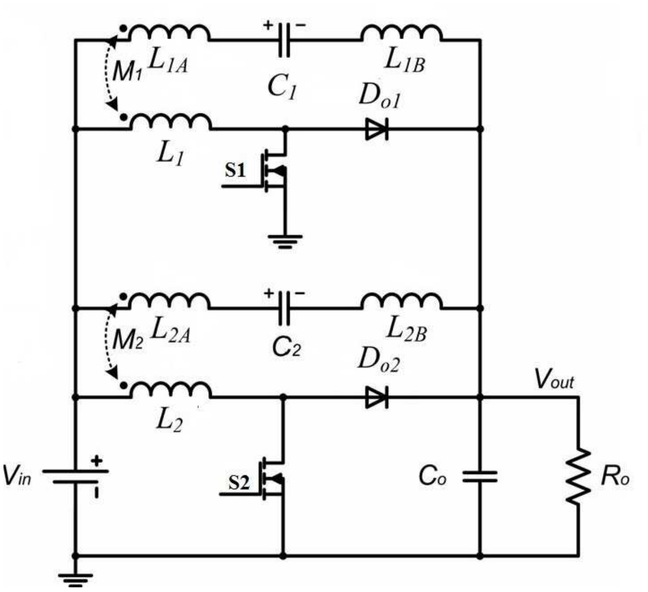


Fig.2 Proposed converter-Circuit diagram

Mode 1 [t_0, t_1]: At t_0, S_1 turns ON and switch S_2 turns OFF. During this period, the inductor L_1linearly charged by the input voltage. Due to this I_{L_1} increases linearly. Due to reverse bias condition D_{01} maintains OFF stage, because of the voltage stress across the diode is equal to the output voltage. Meanwhile the energy stored in the inductor L_2 gets transferred to loadR_0, because of the coupled relation between two inductor , the current I_{L_2} decreases more. Due to this the zero current ripple is achieved.

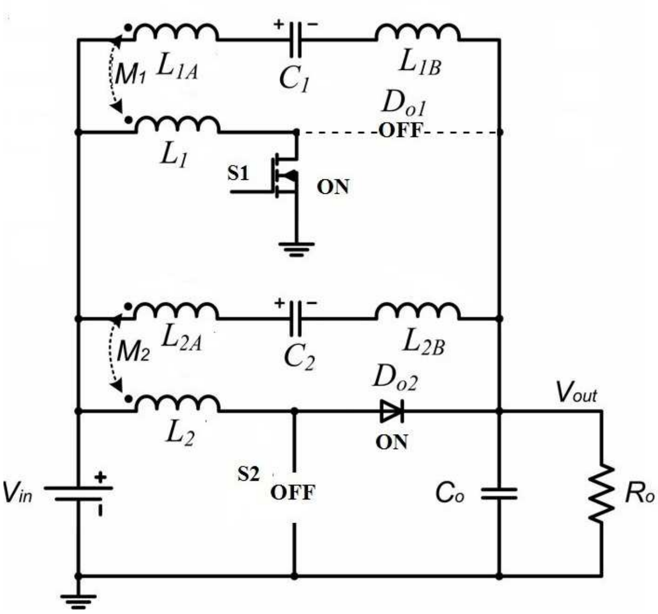


Fig.3 Mode 1 [t_0, t_1]

Mode 2 [t_1, t_2]: At t_1.both switches S_1 and S_2 are in OFF state ,meanwhile the energy from inductor L_1 and L_2 gets transfer to the load R_0. So the current across the inductor $I_{L_1}$and I_{L_2} decreases linearly. During this the voltage across the switch $S_1$and S_2equals to the output voltage .In this mode the coupled inductor branches still work as a filter to minimize the input and output current ripple.

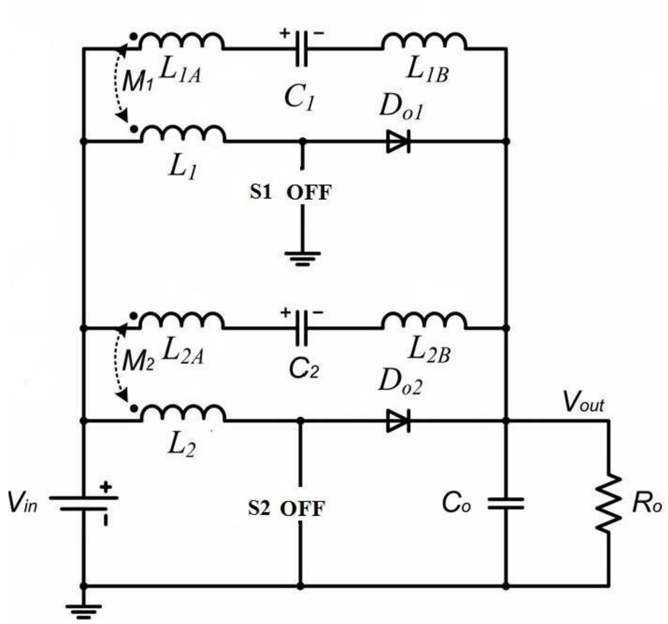


Fig.4 Mode 2 [t_1, t_2]

III.DESIGN OF PROPOSED CONVERTER

1. INDUCTOR

$$L = \frac{D(1-D).R}{2f}$$

$$L = \frac{0.28(1-0.28).13.7}{2*10^5}$$

$$\boldsymbol{L = L_1 = L_2 = 15\ \mu H}$$

2. TIME

$$T = \frac{1}{f}$$

$$T = \frac{1}{100*10^3}$$

$$T = 10\ \mu s$$

3. DUTY CYCLE

$$D = \frac{Vout-Vin}{Vout}$$

$$D = \frac{50-36}{50}$$

$$D = 0.28$$

4. MUTUAL INDUCTANCE

$$M = k\sqrt{L1*L2}$$

$$M = 0.985\sqrt{15*10^{-6}*15*10^{-6}}$$

$$\boldsymbol{M = 5.395\ \mu H}$$

5. RIPPLE

$$r = (V\ or\ I)max - (V\ or\ I)min$$

from graph

6. RIPPLE RATIO

$$r\ \% = \frac{\Delta(V\ or\ I)}{V\ or\ I} * 100$$

IV. SIMULATION RESULTS

A 36–50 V proposed converterwith nominal output power rating isdesigned and simulatedto verify the proposed concept; the converter analysis and design guidelines presented in the previous sections are used for this purpose. The converter consists of a conventional converter and two current ripple cancellation branches. Simulation of the proposed converter was carried out in MATLAB and the key parameters are listed in Table I.

1. SIMULATION DIAGRAMS

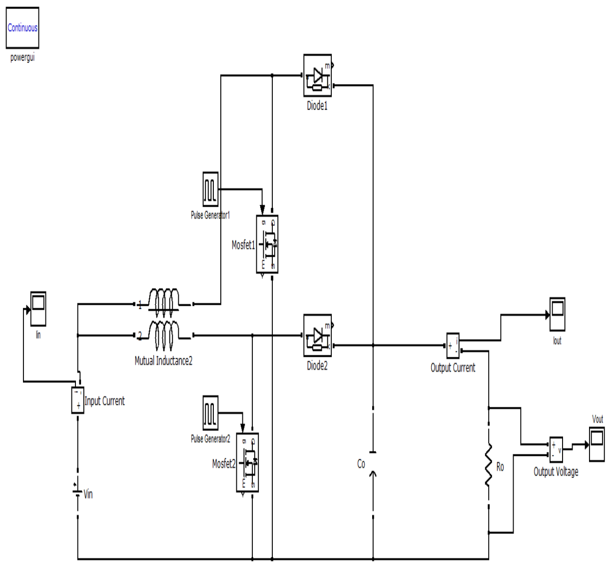


Fig 5 Matlab simulation diagram of conventional converter

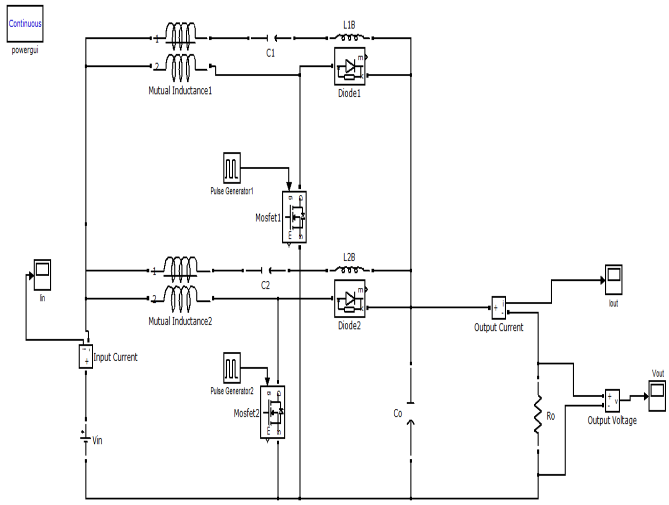
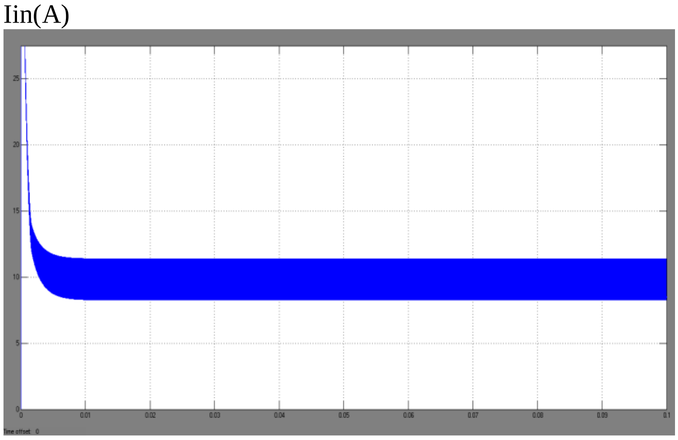


Fig 5 Matlab simulation diagram of proposed converter

2. SIMULATION RESULTS

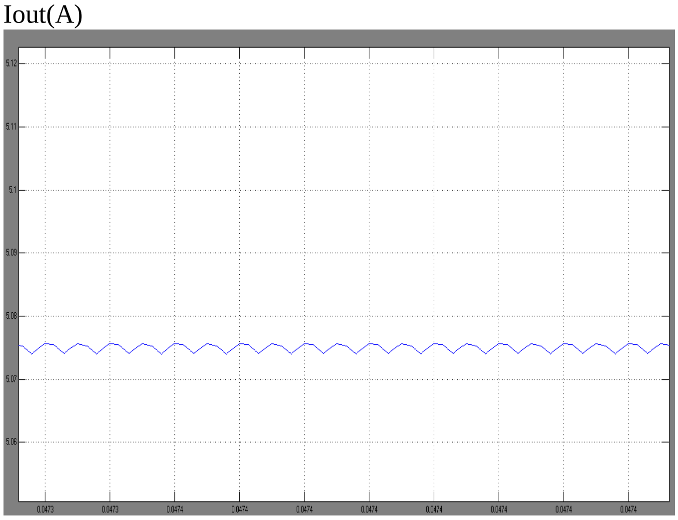
Iin(A)



Time

Fig.6 Conventional converter-Input current ripple waveform

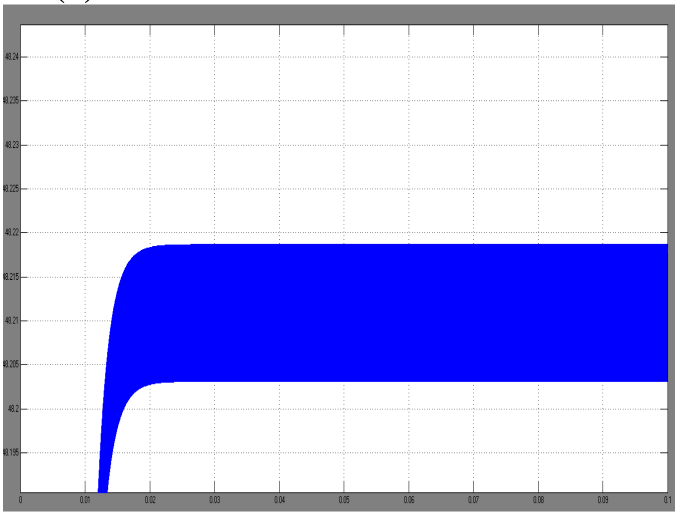
Iout(A)



Time

Fig.7 Conventional converter-Output current ripple waveform

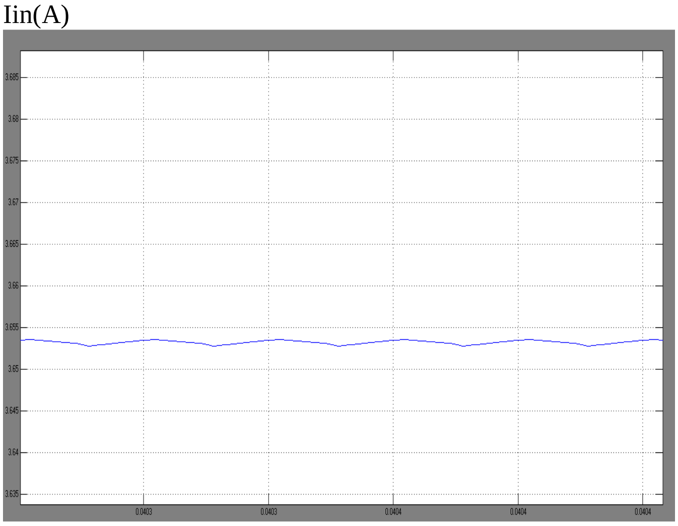
Vout(V)



Time

Fig.8 Conventional converter-Output voltage ripple waveform

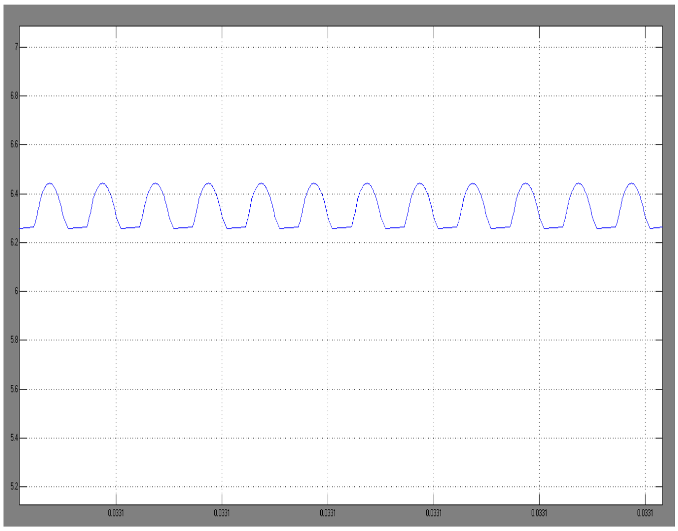
Iin(A)



Time

Fig.10 Proposed converter-Output current ripple waveform

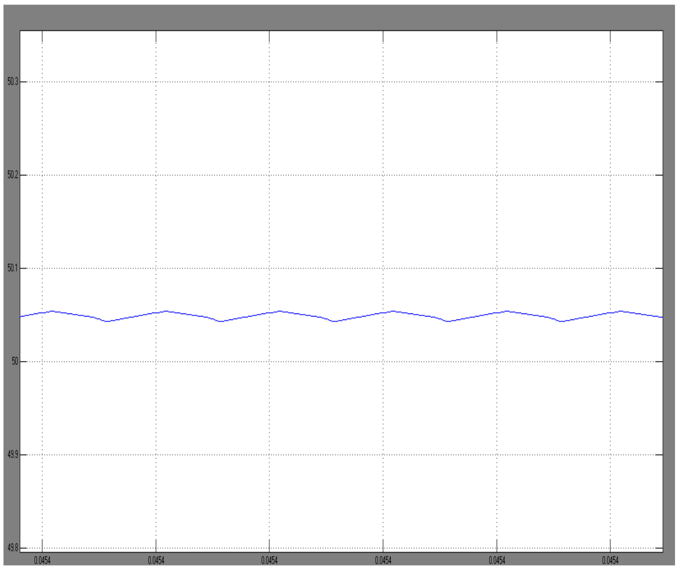
Vout(V)



Time

Fig.9 Proposed converter-Input current ripple waveform

Iout(A)



Time

Fig.11 Proposed converter-Output voltage ripple waveform

V. EXPERIMENTAL VERIFICATION

In order to verify the effectiveness of proposed converter, aprototype is built and tested. The specifications of thetested converter are listed in Table I.The experimental results of the coupled inductor interleaved boost converter,and the proposed converter are shown inTable II. The duty cycle of eachconverter is about 0.3. The input current ripples of the conventional and proposed converters are 2.37A and 0.13A respectively.The output current ripples of the conventional and proposed converters are 0.004A and 0.0012A respectively as shown in Table II.Therefore, the proposed converter is able to minimize the input, output current ripple and also output voltage ripple.

Fig.12 Proposed converter-Experiment prototype

Table-I

Parameters of proposed converter

S.No	Parameters	Value
1	Input voltage (V_{in})	36 V
2	Output voltage (V_{out})	50 V
3	Switching frequency (f_s)	100 Khz
4	Main Inductor (L_1,L_2)	15 µH
5	Coupled inductor ($L_{1A,}L_{2A}$)	2 µH
6	Inductor (L_{1B},L_{2B})	3.3µH
7	Coupling coefficient (K)	0.98
8	Capacitor (C_1, C_2)	10 µF
9	Output capacitor (C_0)	470 µF

Table-II
Comparison of Conventional and Proposed Converter

VI. CONCLUSION

This paper has introduced and developed a coupled inductor interleaved boost converter with low ripple circuit.The proposed converter reduce the input,output current ripple and also output voltage ripple.It can be achieved in all power range by adding two capacitors, two inductors,and coupled inductors.Consequently, it is easy to design and control the proposed converter. At last, a 36–50-V, prototype circuit is implemented to verify the expected performance.Which prove that proposed dc-dc converter has great potential to be used in photovoltaic application.

S.NO	PARAMETERS	COUPLED INDUCTOR INTERLEAVED BOOST CONVERTER	PROPOSED CONVERTER
1	INPUT CURRENT RIPPLE (A)	2.37	0.13
2	INPUT CURRENT RIPPLE RATIO (%)	18.96	1.96
3	OUTPUT CURRENT RIPPLE (A)	0.004	0.0012
4	OUTPUT CURRENT RIPPLE RATIO (%)	0.0781	0.0306
5	OUTPUT VOLTAGE RIPPLE (V)	0.025	0.0166
6	OUTPUT VOLTAGE RIPPLE RATIO (%)	0.05	0.0332

REFERENCES

1. J. R. Pinheiro, H. A. Grundling, D. L. R.Vidor, and J. E. Baggio, "Control strategy of an interleaved boost power factor correction conv-erter," in *Proc.IEEE Power Electron. Spec. Conf.*, 1999, pp. 137–142

2. M. Pahlevaninezhad, P. Das, J. Drobnik, P. K. Jain, and A. Bakhshai, "AZVS interleaved boostAC/DC converter used in plug-in electric vehicles," *IEEE Trans. Power Electron.*, vol. 27, no. 8, pp. 3513–3529, Aug. 2012.

3. Y. Jang and M. M. Jovanovic, "Interleaved boost converter with intrinsic voltage-doubler characteristic for universal-line PFC front end," *IEEE Trans. Power Electron.*, vol. 22, no. 4, pp. 1394–1401, Jul. 2007.

4. S. Park, Y. Park, S. Choi, W. Choi, and K. B. Lee, "Soft-switched Interleaved boost converters for high step-up and high-power applications," *IEEE Trans. Power Electron.*, vol. 26, no. 10, pp. 2906–2914, Oct. 2011.

5. R. Martinelli and C. Ashley, "Coupled inductor boost converter with input and output ripple cancellation," in *Proc. Appl. Power Electron. Conf. Expo.*, 1991, pp. 567–572

6. Y. Hu,Y.Xie, H. Tian, and B. Mei, "Characteristics analysis of two channel interleaved boost converter with integrated coupling inductor," in *Proc.IEEE Power Electron. Spec. Conf.*, Jun. 2006, pp. 1–6.