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Comparative Analysis Between Directly and Indirectly Coupled Two- Phase Tapped Inductor Boost Converter

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ABSTRACT

In this paper , two different two- phase boost converters with both directly coupled inductors and one with indirectly coupled inductors are compared. Output voltage equations ,Duty Ratio , Equivalent inductances, Mutual inductances for the both the circuits have been calculated. For the same simulations have been made using MATLAB/SIMULINK software and have been presented. Different waveforms have been obtained from simulations and presented in this paper.

KEYWORDS: Interleaved , Coupled- Inductor , Boost Converter MOSFET ,CCM, Directly coupled, Inversely coupled , MATLAB,SIMULINK

1. INTRODUCTION

The Boost converter is an exceptionally famous non-isolated topology to transfer the input voltage into a higher yield voltage. DC-DC Converters with a high boosting capacity are needed in arising applications, with no disengagement. Applications models are photovoltaic frameworks, continuous force supplies, car head lights and telecom frameworks.

Be that as it may, the utilization of this present inductor support converter having a high value of turns proportion which makes sure it is conceivable to accomplish higher move forward proportions with a lower duty ratio.

The grid of tapped inductor design is examined underneath:

a) “Diode to tap”
b) “Switch to tap”
c) “Rail to tap”

For this section, a 2-Ø Tapped-coupled inductors Boost converters are portrayed with discussion. Examination is accomplished for both directly coupled and indirectly coupled converters which are working in CCM mode of operation. Articulations respective to output voltages and converter waveforms in CCM will be introduced.

2. ANALYSIS OF THE CONVERTER:

2-Ø Directly Tapped-Coupled Inductor Boost conveter" :[1]

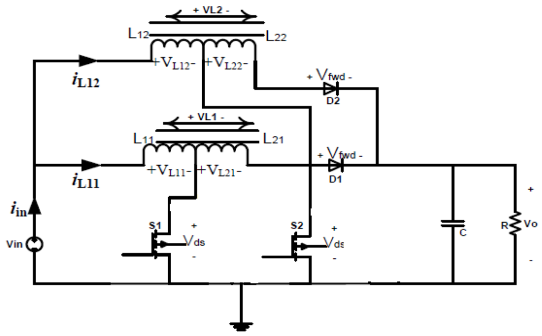

Figure 2(a). "Two-phase Boost converter topology"

The proposed converter circuit parts has the following components:
MOSFET S_1 and S_2 , Diodes D_1 and D_2 , a capacitor C and resistor R.
The inductors L_{11} , L_{21} are together coupled and are switch tapped also they are interconnected with the main converter, also the inductors L_{12} and L_{22} are also coupled and switch tapped like previous inductors and connected to other converter.
The voltage acquire is reached out by choosing a legitimate turns proportion for both the coupled-inductors. The ripple reduction of the converter will be shown as a component of Phase number (N) an
along with the Duty ratio(D).

The operation are of four stages given as:

- For interval 0< t < D_1 Tsw where S_1 conducts .
- For interval D_1 Tsw< t < 0.5Tsw .
- For interval 0.5Tsw< t < (0.+D_2)Tsw , when S_2 conducts
- For interval (0.5+Ds)Tsw< t < Tsw when no switch conducts.

2-Ø Inversely Tapped-Coupled inductor Boost converter":

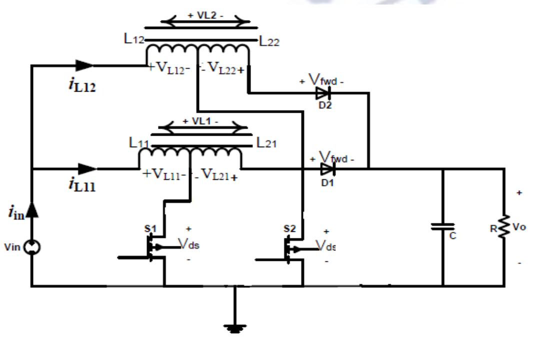

Figure 2(b). Circuit Topology "2-Ø Inversely Tapped-coupled inductor converter".

The selected converter has the following components:

MOSFET switches S_1 , S_2 , the Diodes D_1& D_2 , a capacitor C and a resistor R
The inductors L_{11}& L_{21} are switch tapped and are coupled together and connected with the primary of converter.
The inductors L_{12}& L_{22} are both coupled and tapped and connected with the second converter.

The operation has four different intervals as follows:

- For interval 0< t <D_1Tsw , S_1 conducts , S_2 is OFF.
- For interval D_1 Tsw< t < 0.5Tsw No switch is conducting.
- For interval 0.5Tsw< t < (0.+D_2)Tsw , only S_2 conducts
- For interval (0.5+Ds)Tsw< t < Tsw , none of switches conduct

3. THEORETICAL WAVEFORMS

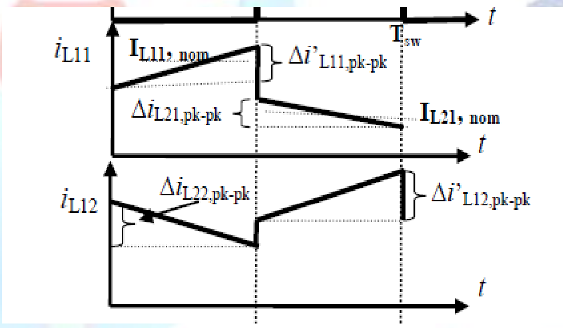

Figure 3(a)Phase and Input currents

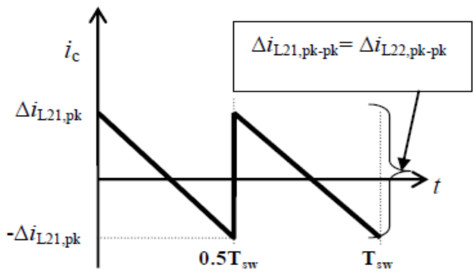

Figure 3(b) Capacitor current

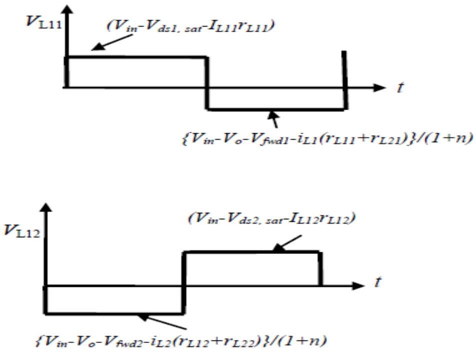

Figure 3(c):Voltage waveforms

4. SIMULATION RESULTS WITH DISCUSSION

Two-phase Directly tapped-coupled inductor converter:

Parameters considered:

V_{in} = 40V , V_o = 400V

n = 10

L1=L2=1000µH

C=47µH

fsw = 100KHz

D=0.2

L3=L4=1000µH

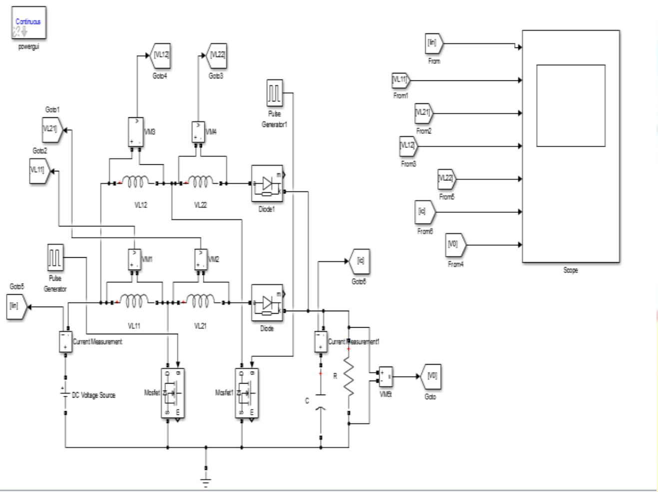

Figure 4(a). simulink model of two-phase directly tapped-coupled inductor boost converter

Simulation plots:

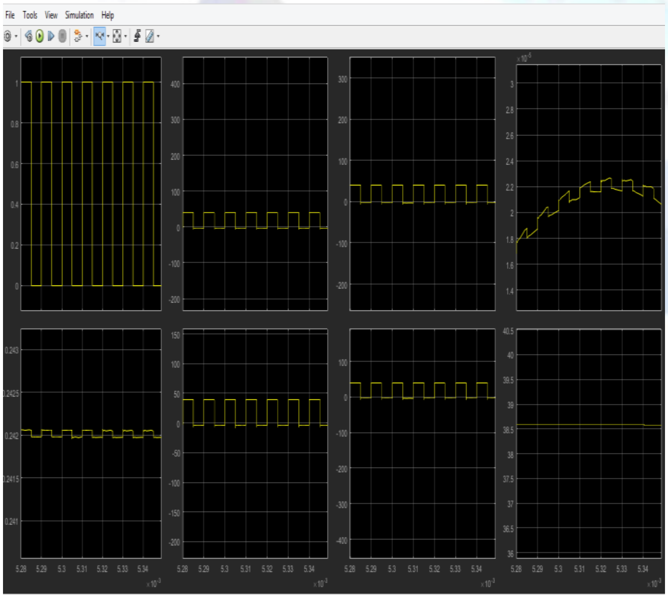

Figure 4(b) : Simulations plot for Gate pulses, VL_1 , VL_2 , IL_1, IL_2 , V_O for directly tapped-coupled inductor

Two-phase Inversely tapped-coupled inductor boost converter:

Parameters considered:

V_{in} = 40V n = 10 L1=L2=1000µH C=47µH fsw = 100KHz

V_o = 400V D=0.2 L3=L4=1000µH R=100Ω

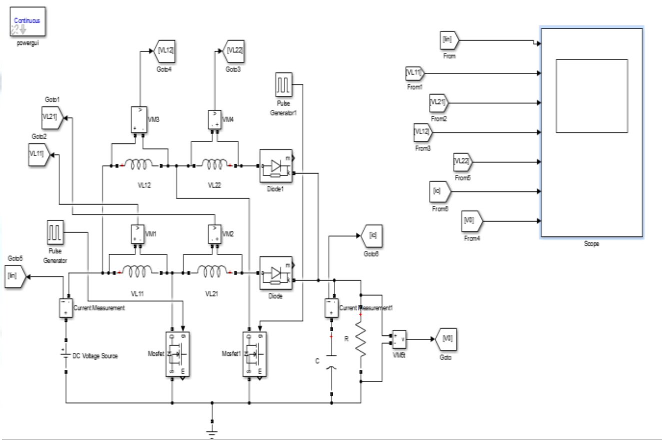

Figure 4(c). simulink model of two-phase inversely tapped-coupled inductor boost converter

Simulation plots:

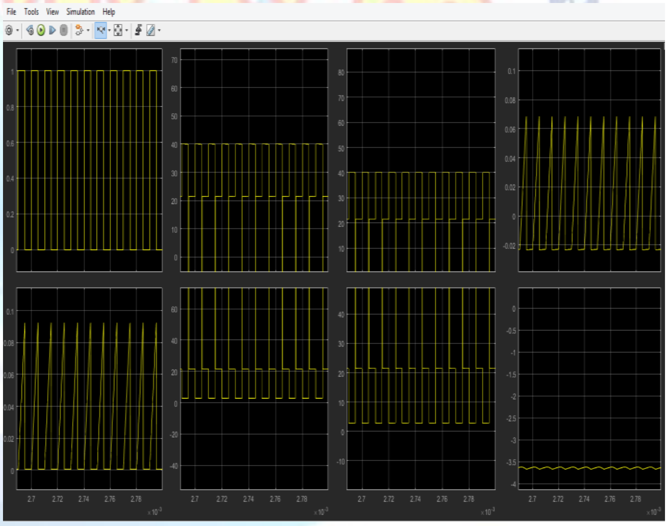

Figure 4(d) Simulations plot for Gate pulses, VL_1 , VL_2 , IL_1 , IL_2 , V_O for Inversely tapped-coupled inductor

5. OBSERVATIONS:

In case of Directly coupled inductors , calculated (L_{eq}) obtained is greater than the(L_{eq}) obtained in case of inversely coupled inductors ..

6. CONCLUSION

In this particular section we have examined about the performance of 2-Ø Tapped-coupled inductor Boost converters. We have seen the effects of these inductors on the overall performance . For this particular dc-dc

Boost converter the voltage transfer ratio has been presented. We have seen that in very low values of duty ratios we have achieving higher values of boost ratios . We have also shown that value of ripple reduction is a functional component of both duty ratio(D) and Phase number (N).

We have observed that the in both the current waveforms and voltage waveforms ripple cancellations are seen which is one of the advantages of this converter.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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