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Design of Single Input Multiple Output DC-DC Converter

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***Abstract*- The aim of this study is to developed a high efficiency single input multiple output dc-dc converter. The converter proposed can boost the voltage of a low voltage input power source to a controllable high voltage dc and middle voltage output terminals. The high voltage dc can be taken as the main power for a high voltage dc load or for the front terminal of a dc ac inverter. Middle voltage output terminals can supply power for individual middle voltage dc loads or for charging auxiliary power sources (e.g., battery module). In this, a couple inductor with dc-dc converter scheme utilizes only one power switch with the properties of voltage clamping, soft switching, and the corresponding device specifications are designed. The switching pulse for the switch is provided by the controller. As a result, the objectives of high efficiency conversion, step-up ratio, and output voltage with different level can be obtained.**

Keywords*- *Coupled inductor, high efficiency power conversion, single input multiple output converter, soft switching, voltage clamping.

I. INTRODUCTION

This converter is a newly designed single input multiple output dc –dc converters with coupled inductor. The proposed converter uses only one power switch and main objectives of high-efficiency power conversion, and different outputs, high step-up ratio. The techniques of soft - switching and voltage clamping are used to reduce the switching loss and conduction loss a dc-dc converter is an electronic circuit which is used to convert a source of direct current (dc) from one voltage level to another voltage level. The boost converter is a single input single output device. To obtain multiple outputs, number of switches will be increases. This in turn increases the switching loss and stress. And that efficiency is low. The existing system is single input single output dc-dc converter with different voltage gains are combined to satisfy the requirement of different voltage levels, so this system control is complicated and cost is high. The existing system of the single input multi output dc-dc converter has a more than three switches for one output were required. In this method only suitable for low voltage and low power applications. High efficiency isolated boost dc-dc converter for high power low voltage application. The high efficiency boost converter used for boosting the input voltage to obtain maximum output voltage. The proposed system are increasing the conversion efficiency and reduce the manufacturing cost voltage gain, and control complexity. The middle capacitor voltage is depends on auxiliary inductor. The output of the high voltage de bus can be controlled.

II. CONVERTER DESIGN AND ANALYSES

The system configuration of the proposed high efficiency SIMO converter topology to generate different voltage levels from a single input power source is depicted in fig.1. This SIMO converter contains five parts including a low voltage side circuit(LVSC), a clamped circuit, a middle voltage circuit ,an auxiliary circuit, and a high voltage side circuit(HVSC). The major symbol representation are summarized as follows.VFC(IFC) andV01(I01) denote the voltage(currents) of the input power source and the output load at the LVLSC and the auxiliary circuit, respectively; V02 andI02 are the output voltage and current in the HVSC. CFC,C01 and C02 are the filter capacitor at the LVSC, the auxiliary circuit and the HVSC,respectively;C1 and C2 are the clamped and middle voltage capacitors in the clamped and middle voltage circuits ,respectively .LP and LS represent individual inductors in the primary and secondary sides of the couple inductor Tr, respectively, where the primary side is connected to the input power source ;Laux is the auxiliary circuit inductor. The main switch is expressed as S1 in the LVSC; the equivalent load in the auxiliary circuit is represented as R01 and the output load is represented as R circuit given in fig.2 is used to defined the voltage polarities and current directions. the coupled inductor in fig.1 can be modeled as an ideal transformer are defined as

$$N = N2/N1 \qquad (1)$$

$$K = \frac{Lmp}{(Lkp+Lmp)} = \frac{Lmp}{Lp} \qquad (2)$$

Where N1 and N2 are the winding turns in the primary and secondary side a of the coupled inductor Tr. Because the voltage gain is less sensitive to the coupling coefficient and clamped capacitor C1 is appropriately selected to completely absorb the leakage inductor energy, the coupling coefficient could be simply set at one(k=1) to obtain Lmp=Lp via (2).

In this study, the following assumptions are made to simplify the converter analyses: 1) The mains switch including its body diode is assumed to be an ideal switching element; and 2) The conduction voltage drops of the switch and diodes are neglected.

III. OPERATION MODES

The characteristics waveforms are depicted in fig.1 and the topological modes in one switching cycle are illustrated in fig.1.

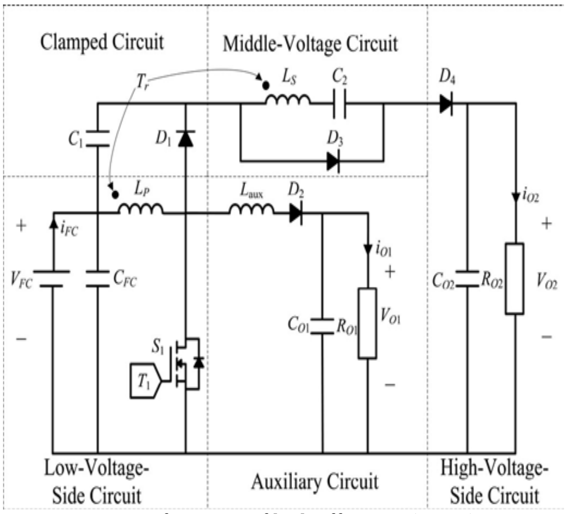

Fig.3.1. System configuration of high-efficiency (SIMO) converter

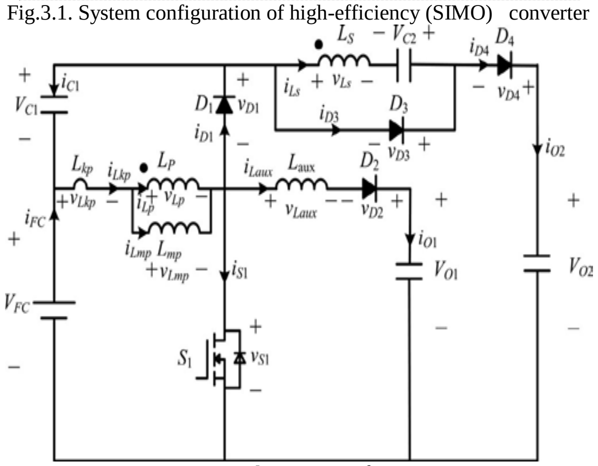

Fig.3.2. Equivalent circuit of SIMO Converter

1 Mode: Mode 1(0-t1) –In this mode, the main switch S1 was turned ON for a span, and the diode D4 turned OFF. Because the positive polarity of the winding of the coupled inductor Tr, the diode D3turn ON. ILS is the secondary current reverses and charges to the middle voltage capacitor C2.When the auxiliary inductor Laux releases its stored energy completely, and the diode D2 turns OFF, this mode ends.

2 Mode: Mode 2(t1-t2) – In this mode, At time t=t 1, the main switch S1 is turned ON. Because the primary inductor Lp is charged by the input power source, the magnetizing current ILmp increases gradually in an approximately linear way. At the same time, the secondary voltages vLS charges the middle voltage capacitor C2 through the diode D3.Although the voltage VLmp is equal to the input voltage VFC both at modes 1 and 2, the ascendant slope of the leakage current of the coupled inductor ($diLkp$ /dt) at modea1 and 2 is different due to the path of the auxiliary circuit. Because the auxiliary inductor Laux releases its stored energy completely, and the diode D2 turns OFF at the end of mode 1, it results in the reduction of ($diLkp$ /dt) at mode 2.

3Mode: mode 3(t2-t3) –At time t=t2, the main switch S1 is turned OFF. When the leakage energy still released from the secondary side of the coupled inductor, the diode D3 persistently conduct and leakage energy to the middle voltage capacitor C2. When the voltage across the main switch vs1 is higher than the voltage across the clamped capacitor Vc1, diode D1 conducts to transmit the energy of the primary side leakage inductor Lkp into the clamed capacitor C1.Atthe same time partial energy of the primary side leakage inductor Lkp is transmitted to the auxiliary inductor Laux and the diode D2 conducts. Thus, the current iLaux passes through the diode D2 to supply the power for the output load in the auxiliary circuit. When the secondary side of the coupled inductor releases its leakage energy completely, and the diode D3 turns OFF, this mode ends.

4 Mode: Mode 4 (t3-t4) - At time t = $t3$,the main switch $S1$ is persistently turned OFF. When the leakage energy has released from the primary side of the coupled inductor, the secondary current iLS is induced in reverse from the energy of the magnetizing inductor Lmp through the ideal transformer, and flows through the diode $D4$ to the HVSC. At the same time, partial energy of the primary side leakage inductor Lkp is still persistently transmitted to the auxiliary inductor Laux, and the diode $D2$ keeps to conduct. Moreover, the current $iLaux$passes through the diode $D2$ to supply the power for the output load in the auxiliary circuit$iLaux$.

5 Mode: Mode 5 ($t4$ –$t5$) - At time t = $t4$, the main switch $S1$ is persistently turned OFF, and the clamped diode $D1$ turns OFF because the primary leakage current $iLkp$ equals to the auxiliary inductor current $iLaux$. In this mode, the input power source, the primary winding of the coupled inductor Tr , and the auxiliary inductor Laux connect in series to supply the power for the output load in the auxiliary circuit through the diode $D2$. At the same time, the input power source, the secondary winding of the coupled inductor Tr , the clamped capacitor $C1$, and the middle voltage capacitor ($C2$) connect in series to release the energy into the HVSC through the diode4

6 Mode: Mode 6 ($t5$ –$t6$) - At time t=$t5$, this mode begins when the main switch $S1$ is triggered. The auxiliary inductor current $iLaux$ needs time to decay to zero, the diode $D2$ persistently conducts. In this mode, the input power source, the clamped capacitor $C1$, the secondary winding of the coupled inductor Tr , and the middle-voltage capacitor $C2$ still connect in series to release the energy into the HVSC through the diode $D4$. Since the clamped diode $D1$ can be selected as a low-voltage Schottky diode, it will be cut off promptly without a reverse-recovery current. Moreover, the rising rate of the primary current $iLkp$ is limited by the primary-side leakage inductor. Thus, one cannot derive any currents from the paths of the HVSC, the middle-voltage circuit, the auxiliary circuit, and the clamped circuit. As a result, the main switch $S1$ is turned ON under the condition of ZCS and this soft-switching property is helpful for alleviating the switching loss. When the secondary current iLs decays

to zero, this mode ends. After that, it begins the next switching cycle and repeats the operation in mode 1.

IV. CONCLUSION

It can be this study has successfully developed a high-efficiency SIMO dc-dc converter, and this coupled inductor based converter was applied well to a single input power source plus output terminals composed of an auxiliary battery module and a high voltage dc bus. The propose SIMO converter is suitable for the application required one common ground, which is preferred in most application .However, it is not appropriate to be used as the active front for dc-ac multilevel inverter. This limitation is worthy to be investigated in the future research

The major scientific contributions of the proposed SIMO converter are recited as follows:1) this topology adopt only one power switch to achieve the objective of high efficiency SIMO power conversion; 2) the voltage gain can be substantially increased by using a coupled inductor; 3) the stray energy can be recycled by a clamped capacitor into the auxiliary battery module or high voltage dc bus to ensure the property of voltage clamping.

REFERENCES

[1] Mohan .N, UndelandT.M, and Robbins.W.P; Power Electronics: Con-verters, Applications, and Design. New York: Wiley, 1995

[2] A. Nami, F. Zare, A. Ghosh, and F. Blaabjerg, “Multiple-output DC–DCconverters based on diode-clamped converters configuration: Topology and control strategy,” IET Power Electron., vol. 3, no. 2, pp. 197–208, 2010

[3] Sujata Verma, S.K Singh and A.G. Rao, "Overview of control Techniques for DC-DC converters" Research Journal of Engineering Sciences Vol. 2(8), 18-21, August (2013)

[4] S. K. Anuja, R. Satheesh Kumar, "A High Efficient DC-DC Converter with Soft Switching for Stress Reduction" International Conference on VLSI, Communication & Instrumentation (ICVCI)2011

[5] hulasi V. S, H. Satish Kumar,"Single-Input Double Output High Efficient Boost DC–DC Converter" International of Modern Engineering Research (IJMER)" Vol. 4 Iss. 3 Mar2014. [6] H.Wu, R. Chen, J. Zhang, Y. Xing, H. Hu, and H. Ge, “A family of three port half-bridge converters for a stand-alone.