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DESIGN AND IMPLUMENTATION OF A BI-DIRECTIONAL BOOST CONVERTER BY USING COUPLED INDUCTOR TECHNIQUE

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Abstract - *This paper studies a bidirectional D C-D C converter with high conversion ratio for renewable energy systems. The coupled-inductor technique is used to achieve a high conversion ratio with very simple control circuits. In discharging mode, the converter acts as a two-stage boost converters, controlling one power switch to achieve high voltage step-up conversion. In charging mode, the converter acts as two cascaded buck converters that control two power switches simultaneously to achieve high voltage step-down conversion. The operating principles and analysis of the steady-state characteristics are discussed in great detail. Finally, a circuit 24/78V is simulated in MATLAB/SIMULINK.*

Key Words: Bidirectional converter, high conversion ratio, coupled-inductor.

1.INTRODUCTION

The bidirectional DC-DC converter is widely used in renewable energy applications. This converter is able to transfer or balance energy between two different DC sources, such as fuel cell and battery hybrid supplied power systems, island photovoltaic generation systems, and wind power systems [1]–[3]. The bidirectional DC-DC converter can be applied in uninterruptible power supplies (UPSs) to transfer the energy between source a n d battery [4]. The bidirectional DC-DC converter plays an important role in system back up or in reserving energy for the battery. Figure 1 shows the application of this converter in a hybrid renewable energy supply s ys t e m . The battery can balance the energy between the power source and the load. The voltage difference between the battery and the DC bus is large, thus, a bidirectional DC-DC converter with high step-up/down voltage conversion ratio is required. The conventional boost/buck bidirectional converter is not suitable in such applications because the conversion ratio will be significantly reduced by parasitic elements. the active components of the single-stage cascaded bidirectional DC-DC converter will suffer higher current stress and conduction losses [5]. The bidirectional converter used coupled-inductor technology to achieve a high voltage conversion ratio [6]–[8]. However, the energy stored in the leakage inductor of the coupled inductor causes a high voltage spike on the power switches [9]–[11].

The bidirectional converter being studied is constructed of a dual boost/buck converter to achieve a high voltage conversion ratio by employing a coupled-inductor technique. Fig. 2 shows the configuration of the bidirectional converter, which has the following features: 1) the converter achieves high voltage conversion ratio at step-up or step-down stage; 2) solitary control with signal in either step-up or step-down operating condition, an effectively simplified control circuit; 3) the leakage-Inductance energy of the coupled inductor is r e c y c l e d , thus reducing the voltage stress on power switches; 4) a low RDS-ON switch can be selected to improve system efficiency.

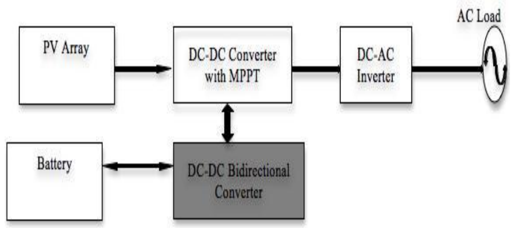

Fig. 1 Renewable energy hybrid supply system.

II.CONFIGURATION OF BIDIRECTIONAL CONVERTER

The converter is used for the bidirectional transfer of energy between the low voltage side VL, which is connected to a 24 V battery, and the high voltage side VH, which is connected to a 78 V DC bus. Fig. 2 shows the configuration of the bidirectional converter.

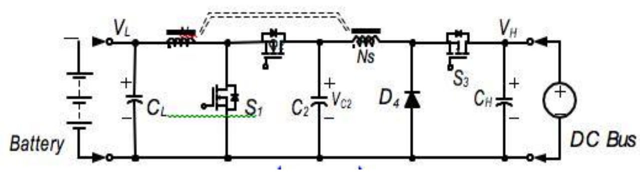

Fig. 2 shows the configuration of the bidirectional converter.

The following conditions were assumed in analyzing the steady-state characteristics of the proposed converter:

All the circuit components are ideal. The capacitors CL, C2, and CH are large enough, and the voltages can be treated as constant. The magnetizing inductance Lm of the coupled inductor is large enough, and the converter is operated in continuous conduct mode (CCM).

The component parameter of coupled inductor turns ratio Np: Ns is 1:3, Lm/Lk is 8/24.In discharging mode, the converter acts as a two-stage boost converters, controlling one power switch to achieve high voltage step-up conversion. The power switch S1 is the main power switch. The switches S2 and S3 are off during the entire period. In charging mode, the converter acts as two cascaded buck converters that control two power switches simultaneously to achieve high voltage step-down conversion. Power switches S2 and S3 are controlled simultaneously and switch S1 is off.

III. SIMULATION RESULTS

The specifications and component parameters are as follows: VL = 24 V, VH = 78 V, fs = 50 kHz, n = 3, Lm = 37µH, CL = 220 µF, and C2 = CH = 300 µF. The circuit is simulated in MATLAB/SIMULINK. The following is the simulation circuit in discharging mode.

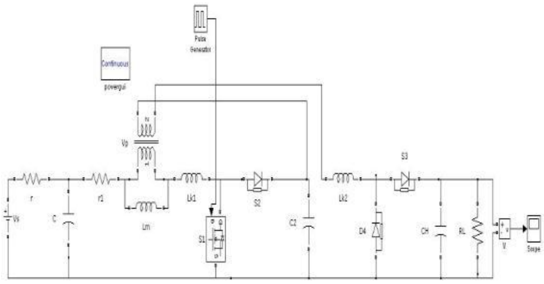

Fig 3. Simulation circuit in discharging mode

The output in discharging mode is shown in Fig 4. It shows the output 24V is boosted up to 78V.

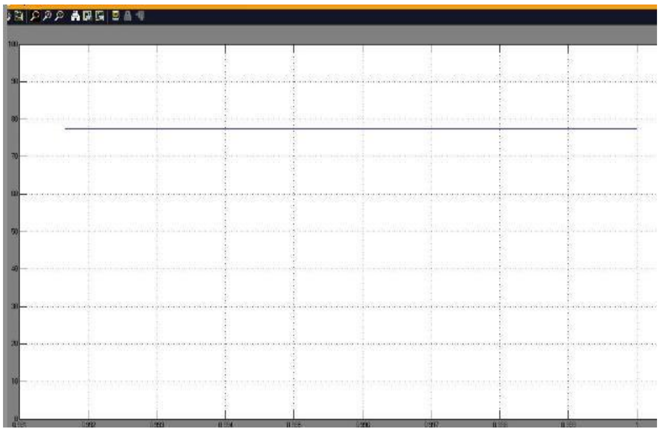

Fig.4. Output in discharging mode

The following is the simulation circuit in charging mode.

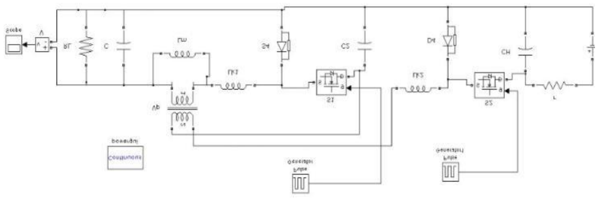

Fig 5. Simulation circuit in charging mode

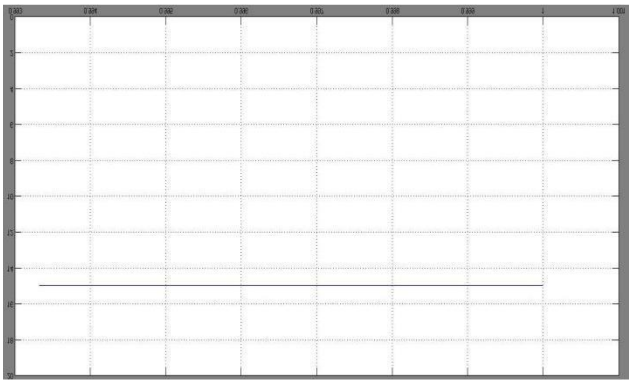

Fig 6.The output in charging mode

The output in charging mode is shown in Fig 6.

IV. CONCLUSIONS

This paper has studied about a bidirectional DC-DC converter for renewable energy systems. The converter can achieve high conversion ratio using the coupled-inductor technique.

REFERENCES

[1] Z. Amjadi and S. S. Williamson, "A novel control technique for a switched-capacitor-converter-based hybrid electric vehicle energy storage system," I E E E Trans. Ind. Electron., vol. 57, no. 3, pp. 926–934, March. 2010.

[2] F. Z. Peng, F. Zhang, and Z. Qian, "A magnetic-less DC–DC converter for dual-voltage automotive systems," I E E E Trans. Ind. Appl., vol. 39,no. 2, pp. 511–518, Mar. 2003.

[3] L. A. Flores, O. Garcia, J. A. Oliver, and J. A. Cobos, "High-frequency bi-directional DC/DC converter using two inductor rectifier," in Proc. IE E E IECON Conf., pp. 2793–2798, Nov. 2006.

[4] M. A. Abusara, J. M. Guerrero, and S. M. Sharkh, "Line-Interactive UPS for Microgrids," IE E E Trans. Ind. Electron., vol. 61, no. 3, pp. 1292–1300, March. 2014.

[5] N. Mohan, T. M. Undeland, and W. P. Robbins, Power Electronics: Converters, Applications and Design, Third Edition, John Wiley & Sons, Inc., 2003.

[6] K. Yamamoto, E. Hiraki, T. Tanaka, M. Nakaoka, and T. Mishima, "Bidirectional DC-DC converter with full-bridge / push-pull circuit for automobile electric power systems," in Proc. IEEE PESC Conf., pp. 1–5, June. 2006.

[7] G. Chen, Y. S. Lee, S. Y. Hui, D. Xu, and Y. Wang, "Actively clamped bidirectional flyback converter," IE EE Trans. Ind. Electron., vol. 47, no. 4, pp. 770–779, Aug. 2000.

[8] N.Rajeswaran, T.Madhu, and M.Suryakalavathi, "Design of Optimized controller for fault diagnosis of Three Phase Induction Motor using Genetic Algorithm ", Applied Mechanics and Materials Vols. 496-500 (2014) pp 1732-1735© (2014) Trans Tech Publications, Switzerland doi:10. 4028/www.scientific.net /AMM.496-500.1732.

[9] B. R. Lin, J. J. Chen, and F. Y. Hsieh, "Analysis and implementation of a bidirectional converter with high conversion ratio," in Proc. IE E E ICIT Conf., pp. 1–6, April. 2008.

[10] L. S. Yang, T. J. Liang, H. C. Lee, and J. F. Chen, "Novel High Step-Up DC–DC Converter with Coupled-Inductor and Voltage-Doubler Circuits," I E E E Trans. Ind. Electron., vol. 58, no.9, pp. 4196–4206, Sept. 2011.

[11] K. I. Hwu and Y.T. Yau, "A Buck Resonant Voltage Divider with Bidirectional Operation Considered," IEEE Trans. Ind. Appl., vol. 49, no. 4, pp.1566–1576, July-Aug. 2013.