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Single Input Multi Output DC-DC Converter Fed to AC/DC Loads

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Abstract: The main aim of this paper is concentrate on an SIMO converter. Additionally, the generated power can be transferred individual power centers and in some cases for battery charging conditions (e.g., battery modules) and for induction motor through Voltage Source Inverter. In this paper, dc–dc converter with coupled inductor system uses only one power switch with the properties of voltage cinching and delicate exchanging. Thus, the targets of high-efficiency power transformation, high stride up proportion, and different output voltages with various levels can be obtained. Theoretical basis of high step up dc-dc converter is described in detail and it is prompted in MATLAB/ SIMULINK.

Keywords: SIMO, DC-DC Converters, Induction Motor, THD

1. INTRODUCTION

In order to protect the environment on the earth, the development of clean energy without pollution gets the major representative role within the last decade. By dealing with the issue of global caution, clean energies, such as gas cell (FC), photovoltaic, and wind energy, etc., have been promoted rapidly [1]-[2]. In this present scenario solar power generation is mainly considered for satellite power system, home appliance and for battery charging. The solar power generators are mainly depends on two factors i.e irradiation and temperature.

The power factor is thought as the percentage of the common power to the obvious power at an AC terminal. Whenever a converter has significantly less than unity power factor, this means that the converter absorbs apparent power greater than the true power it uses. Furthermore, the existing harmonics the converter produces deteriorate the power source quality, which eventually have an impact on the other equipment. The simple solution to increase the charged power factor is to include a passive filtration, which comprises a capacitor and an inductor usually. However, this unaggressive filtration system is heavy and inefficient since it manages at the lines regularity. Therefore, a charged power factor correction stage must be inserted to the prevailing equipment to attain a good power factor. The PFC strategy reduces current harmonics in power systems made by nonlinear loads. [5]. T. Pan, M.C. Cheng, and C.M. Lai shown "Solo inductor multiple output switcher with Simultaneous Buck, Boost, and Inverted Outputs" [15]. That is capable of making buck, boost, and inverted outputs together. However, over three switches for just one end result were required. This scheme is merely suited to the low output voltage and power application, and its electric power alteration is degenerated because of the operation of hard switching [6].

Nami et. al., proposed "Multi-output DC–DC converters based on diode-clamped converters configuration topology and control strategy" a new dc–dc multi-output boost converter, which can share its total output between different series of output voltages for low- and high-power applications. Unfortunately, over two switches for one output were required, and its control scheme was complicated. Besides, the corresponding output power cannot supply for individual loads independently [7, 15].

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2. CONVERTER DESIGN AND ANALYSIS

The proposed configuration of SIMO based dc-dc converter is shown in Figure 1 [8].

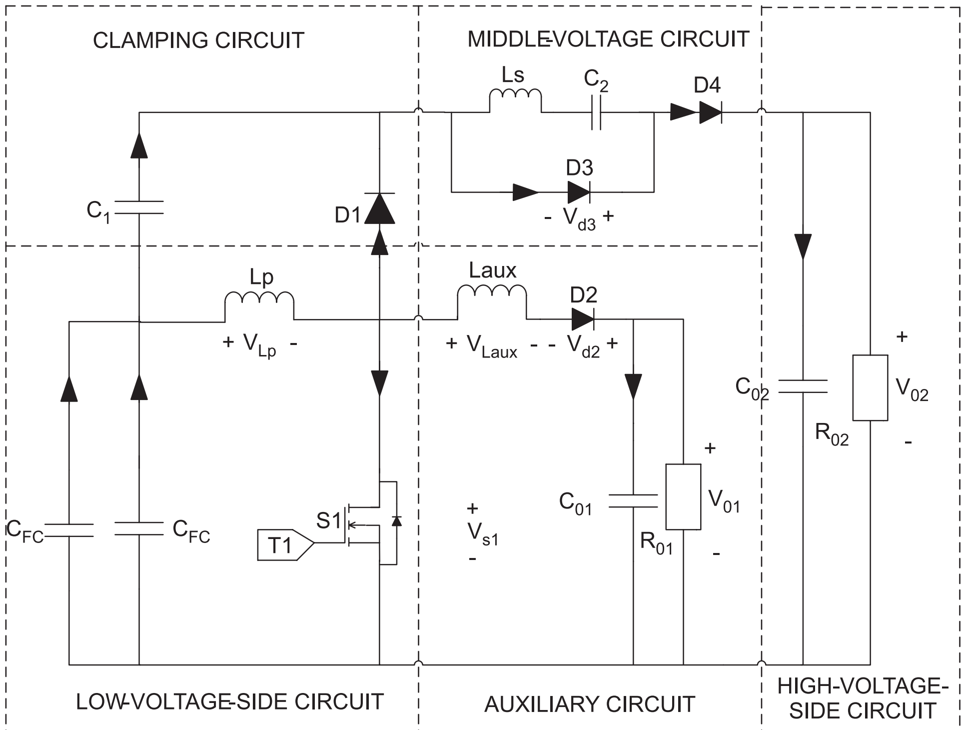


Figure 1: System Configuration of high-efficiency SIMO converter

The significant image representations are condensed as follows. The channel capacitors at the LVSC are C_{FC}, C_{01} and C_{02}, similarly, the capacitors for cinched and center voltage capacitors are chosen as C_1 and C_2. L_P and L_S speak to individual inductors in the essential and optional sides of the coupled inductor T_R, separately, where the essential side is associated with the input power source; Laux is the assistant circuit inductor.

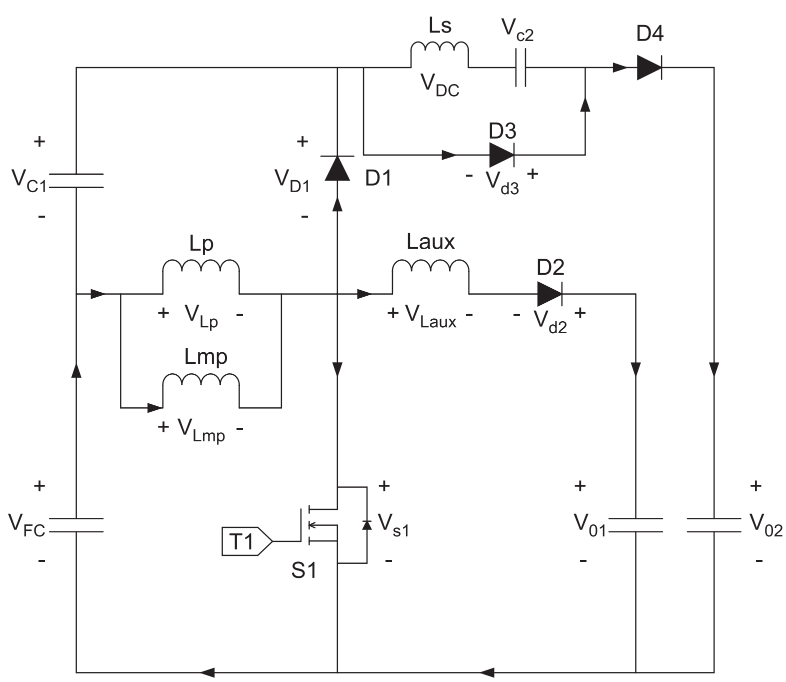


Figure 2: Equivalent Circuit

The turn's ratio N and coupling coefficient k of this ideal transformer are defined as [15]

$$N = \frac{N_2}{N_1} \tag{1}$$

$$K = \frac{L_{mp}}{(L_{kp} + L_{mp})} = \frac{L_{mp}}{L_P} \tag{2}$$

Here N_1 and N_2 are the twisting turns of the coupled inductor T_r [8].

2.1. Operation Modes

1. **Mode 1 ($t_0 - t_1$):** In this case the switch S1 is going to turn-on during the time $t_0 - t_1$ and the diode D4 is goes to OFF state condition. At this condition diode D3 gets turned on. So the center voltage capacitor C2 starts charging.

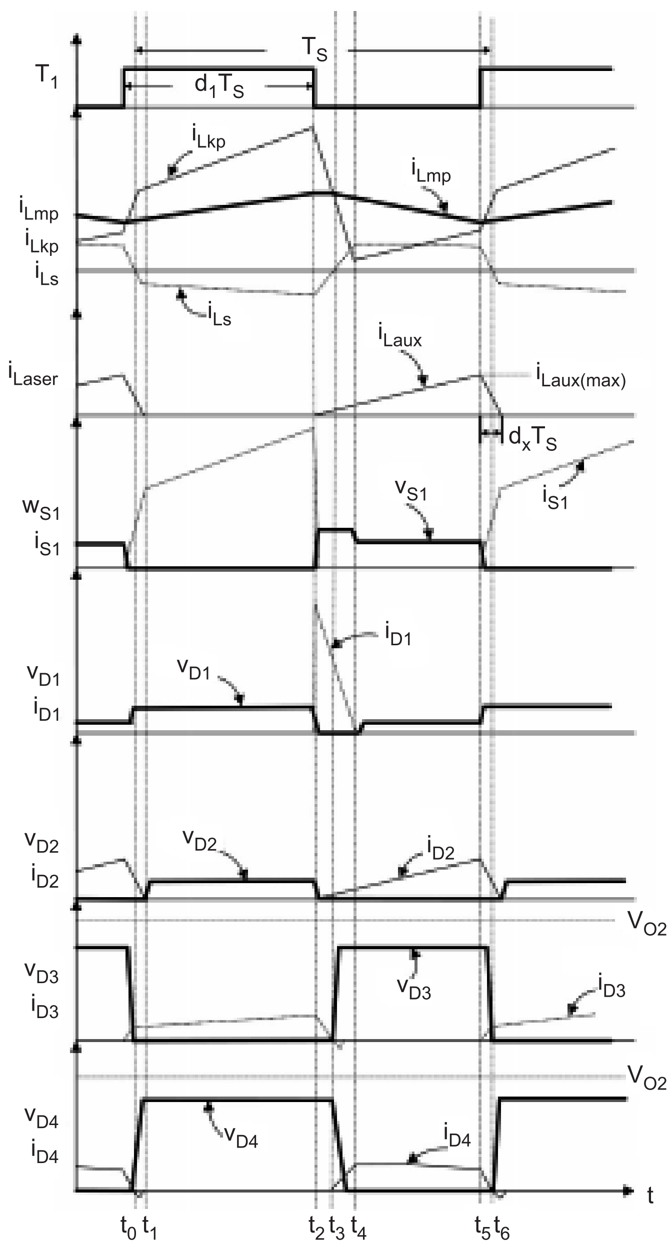


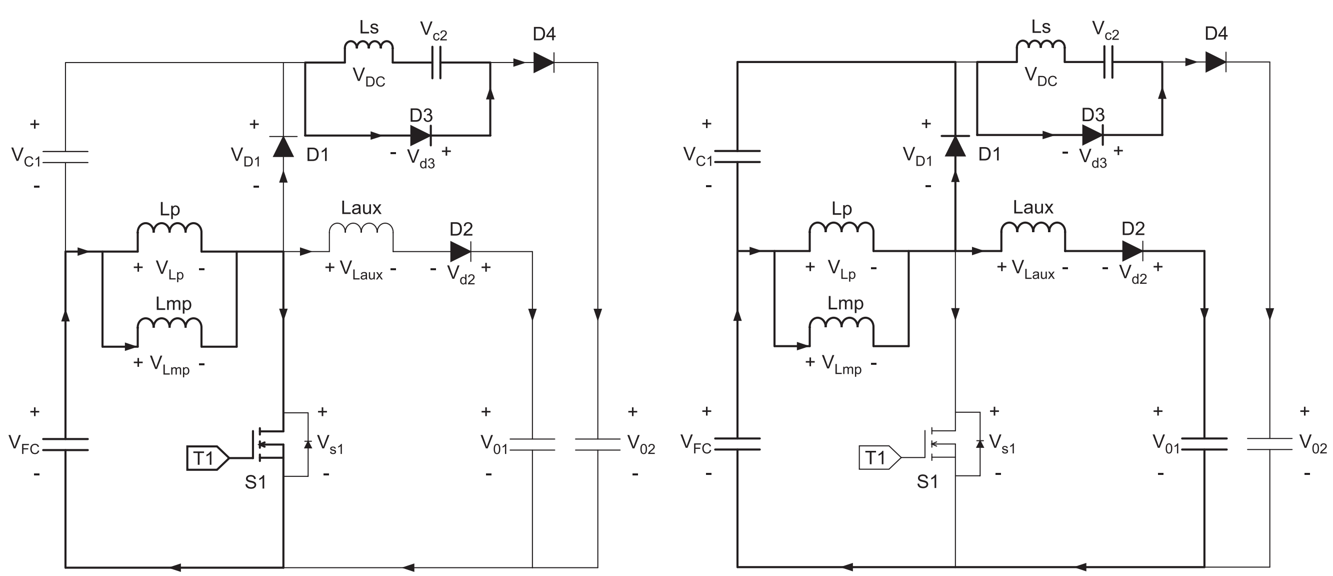
Figure 3: Characteristic waveforms of high-efficiency SIMO converter

2. **Mode 2 ($t_1 - t_2$):** During the time t_1 to t_2 the switch S1 is still in turned ON because of energy stored in the inductor L_p, the polarizing current i_{Lmp} increases steadily. In this time the center voltage capacitor is charged by the optional voltage source.
3. **Mode 3 ($t_2 - t_3$):** At time $t = t_2$, the primary switch S1 is goes to turn off state. At this point the inductor discharges through the optional side of inductor and also the diode D3 discharges the energy stored center voltage capacitor. At the point when the voltage over the fundamental switches V_{S1} is higher than the voltage over the clipped capacitor V_{C1} [15].
4. **Mode 4 ($t_3 - t_4$):** At time $t = t_3$, the principle switch S1 is perseveringly killed. At the point when the spillage vitality has discharged from the essential side of the coupled inductor, the optional current i_{LS} is affected backward from the vitality of the charging inductor L_{mp} through the perfect transformer, and flows through the diode D4 to the HVSC.
5. **Mode 5 ($t_4 - t_5$):** At time $t = t_4$, the fundamental switch S1 is relentlessly killed, and the braced diode D1 kills in light of the fact that the essential spillage current i_{Lkp} equivalents to the helper inductor current $i_{L\ aux}$. In the meantime, the source power, the auxiliary switching of the coupled inductor T_r, the center voltage capacitor and clipped capacitor C2 discharges into the HVSC through the diode D4.
6. **Mode 6 ($t_5 - t_6$):** At $t = t_5$, the main switch is going too triggered. In this case the current through the auxiliary inductor is going to zero. In this mode, the input power source, the clamped capacitor C1, the secondary winding of the coupled inductor T_r, and the middle-voltage capacitor C2 still connect in series to release the energy into the HVSC through the diode D4.

3. PWM TECHNIQUE

The energy that a switching power converter delivers to a motor is controlled by Pulse Width Modulated (PWM) signals applied to the gates of the power transistors [9]. PWM signals are pulse trains with fixed frequency and magnitude and variable pulse width. There is one pulse of fixed magnitude in every PWMperiod. However, the width of the pulses changes from pulse to pulse according to a modulating signal. The turn-on and turn-off periods for transistors is obtained with the help of PWM technique [10].

In this DC-DC boots converter control, Pulse Width Modulation (PWM) control method is employed to draw out maximum power from the available blowing wind power. For this operational system, the research



(a) (b)

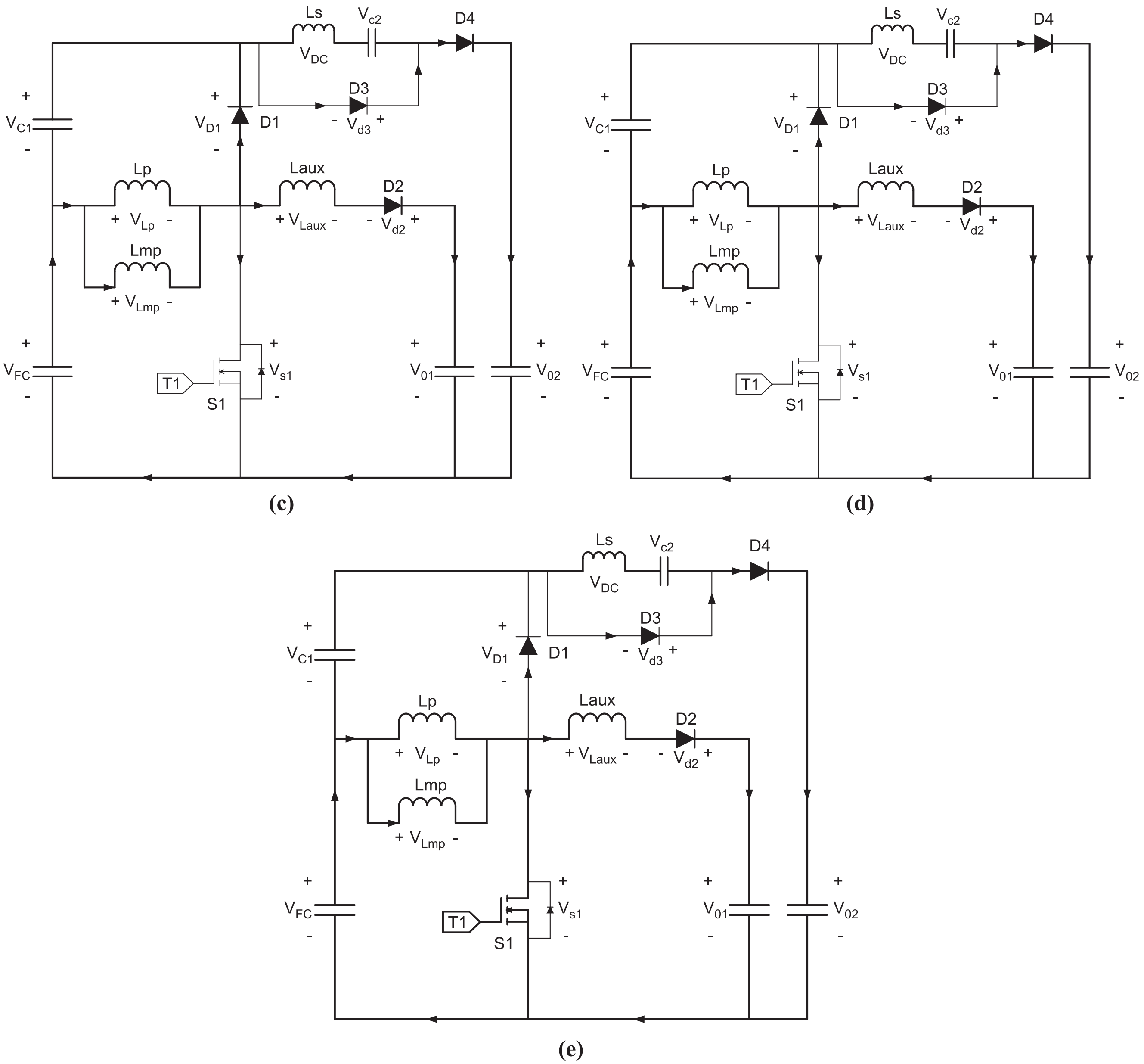


Figure 4: Modes of operation: (a) Mode 1 (b) Mode 2 (c) Mode 3 (d) Mode 4 (e) Mode 5 (f) Mode 6

voltage of 200 V is used to regulate the DC voltage at the rectifier DC area terminals. The reference point voltage is weighed against the genuine voltage from the diode rectifier, and the mistake signal is given to a PI controller. The outcome of PI controller is weighed against carrier triangular influx by moving comparator to regulate the duty routine of the IGBT switch [11]-[12].

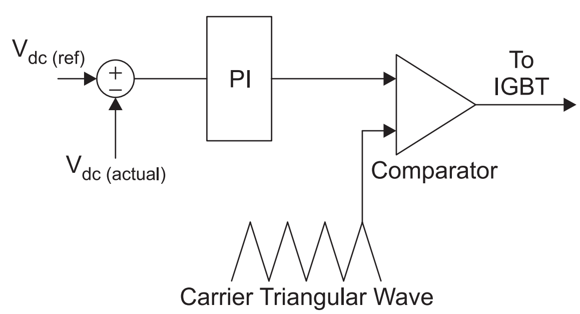


Figure 4. Block diagram of typical DC-DC boost converter controller

4. INDUCTION MOTOR

In adjustable speed drives, ac machines are most popular and commonly used in industry. In ac machines, Induction Motors are maintenance free, cost effective which is more suitable for adjustable speed drive applications in terms of weight, rotation of speed, size, weight, controllability, efficiency and reliability. The adjustable speed drives are used in all industries to control the speed of IM driving loads reaching from pumps and fans to complex drives [13]. Induction Motors do not have naturally the ability of adaptable speed operation. Due to this reason, earlier dc motors were applied in most of the electrical drives. Due to the recent advances in speed control methods of the IM which will make use in almost all electrical drives [14]. For simulation purpose, induction motor parameters are shown in the following Table 1.

5. SIMULATION RESULTS

The performance of the proposed single input multi machine converter system with induction motor is simulated using Matlab/simulink as per the Figure shown in 1. Figure 5 shows the simulation result for output voltage of the system under low voltage system. It is maintained by the system at a level of 220 V. The simulation result for the system under high voltage side is shown in Figure 6 and it is maintained by

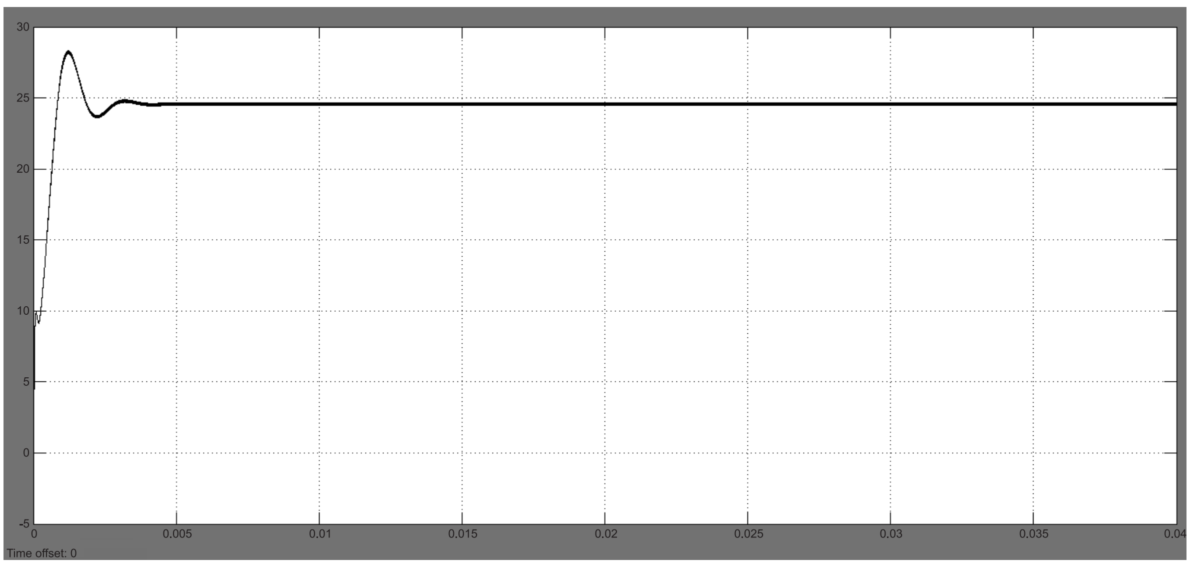


Figure 5: Low Voltage Side Output Voltage

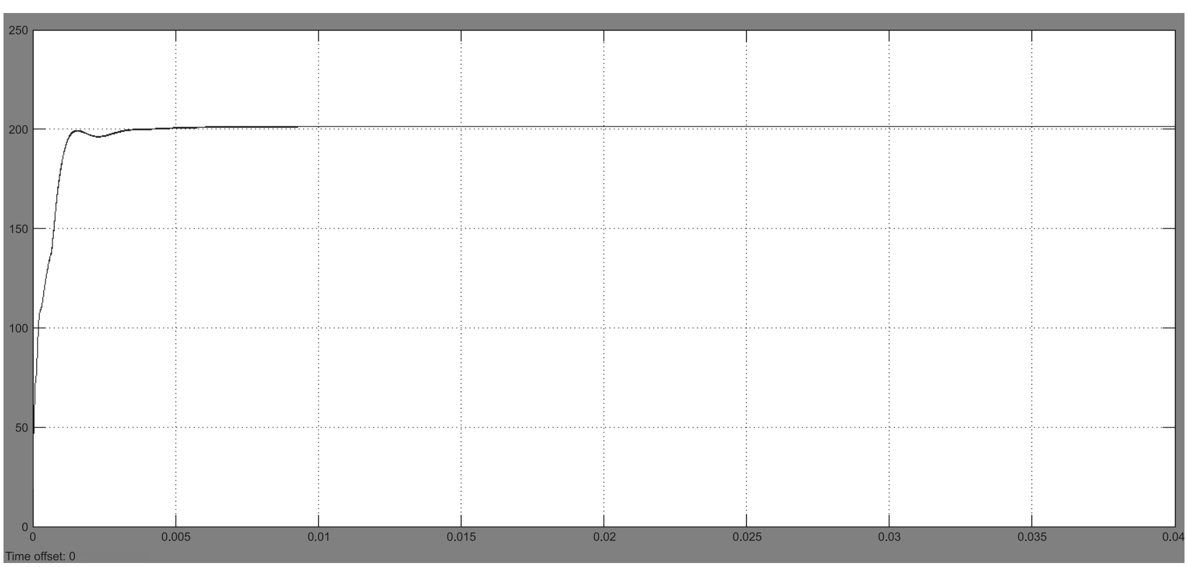


Figure 6: High Voltage Side Output Voltage

the system at the level of 200 V. Figure 7: Simulation Result for I_s & I_r. Figure 7 shows the simulation result for stator and rotor currents for Induction Motor load based SIMO dc-dc converter. The speed-torque characteristics for induction motor based SIMO converter is shown in Figure 8. As we know if the speed of the motor increases linearly then the torque is decreases linearly. The simulation result for output voltage of the single input multi-output dc-dc converter is shown in Figure 9. With this converter the output voltage we are getting is 210 V.

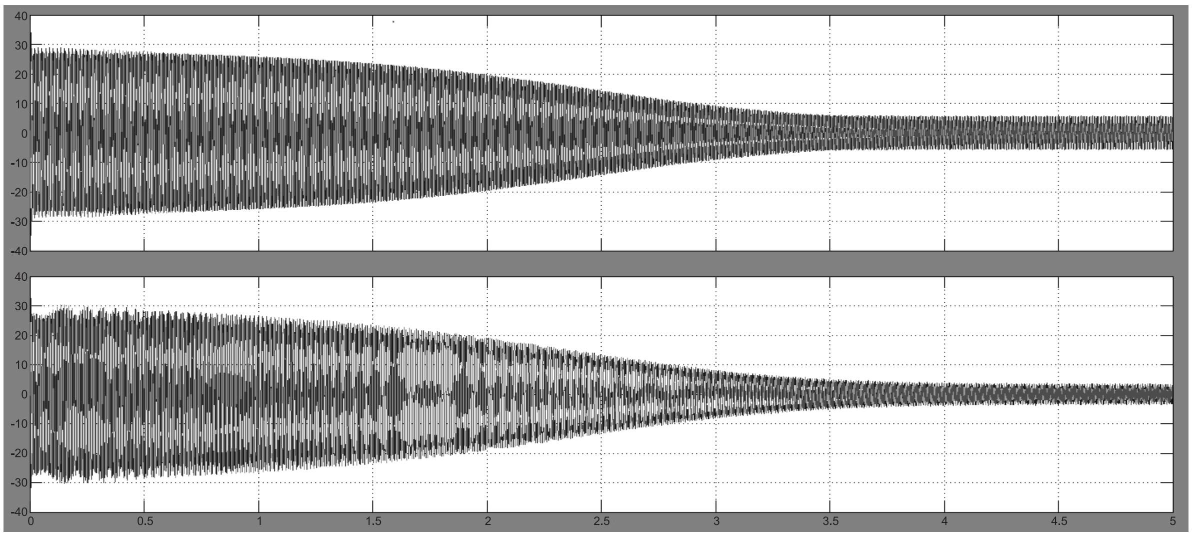


Figure 7: Torque and Speed Response of IM

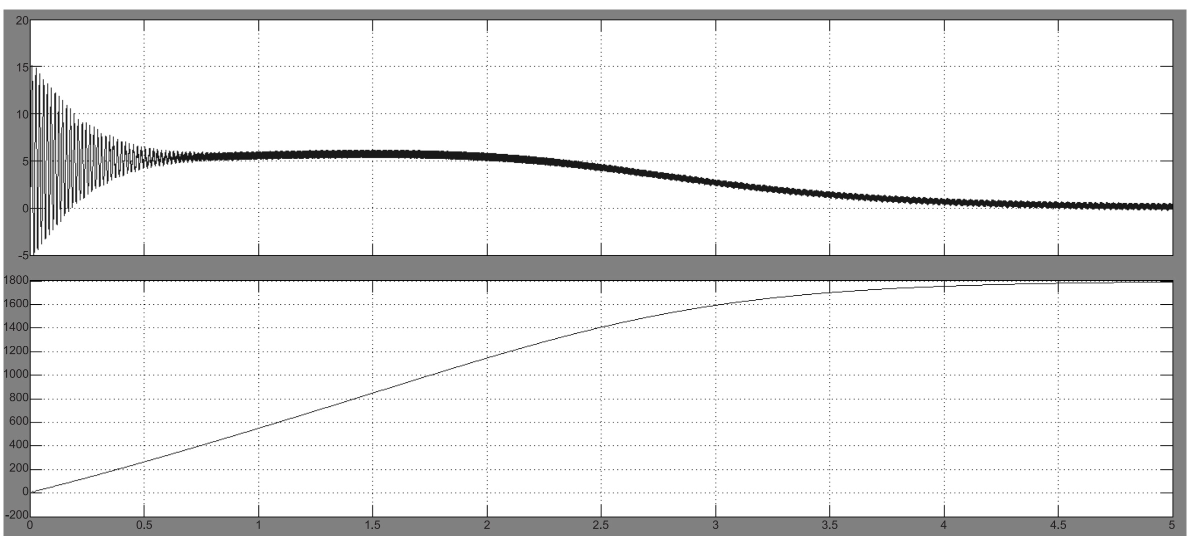


Figure 8: Stator and Rotor Currents of Induction Motor

6. CONCLUSION

A high-efficient single input multi output converter is effectively presented in this paper with coupled inductor and battery module with high voltage dc transport. Simulation results of the conveter reveals that the maximum efficiency was obtained up to 95% and average converter efficiency is approximately 91%. The proposed SIMO converter are remodeled by the following considerations such as, it has only one power switch to achieve high-efficiency SIMO converter, it has high voltage gain with the help of coupled inductor. From these limitations, the proposed SIMO converter has alternative solutions for increasing low-voltage power source to multiple outputs with different levels of voltages.

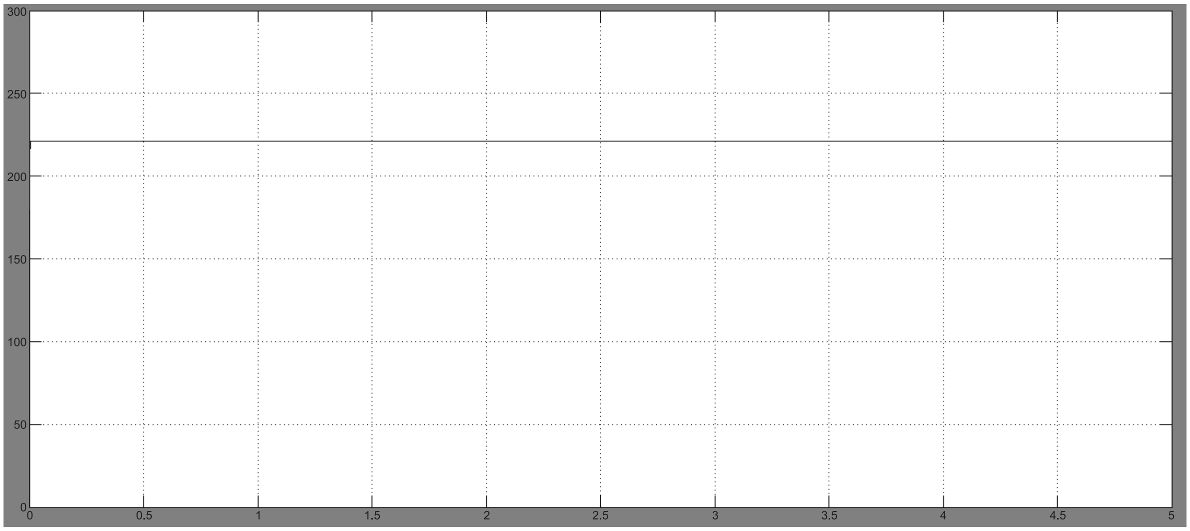


Figure 9: DC Voltage Output of SIMO Converter

References

1. Kirubakaran, S. Jain, and R. K. Nema, "DSP-controlled power electronic interface for fuel-cell-based distributed generation," *IEEE Trans. Power Electron*., Vol. 26, No. 12, pp. 3853-3864, Dec. 2011.
2. 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 renewable power system," *IEEE Trans. Power Electron*, Vol. 26, No. 9, pp. 2697-2706, Sep. 2012.
3. Liu, S. Duan, and T. Cai, "Photovoltaic dc-building-module-based BIPV system-concept and design considerations," *IEEE Trans. Power Electron*., Vol. 26, No. 5, pp. 1418-1429, May 2011.
4. S. D. Gamini Jayasinghe, D. Mahinda Vilathgamuwa, and U. K. Madawala, "Diode-clamped three-level inverter-based battery/ supercapacitor direct integration scheme for renewable energy systems," *IEEE Trans. Power Electron*., Vol. 26, No. 6, pp. 3720-3729, Dec.2011.
5. M.S Jayakumar, Ajeesh G "A High Efficient High Input Power Factor Interleaved Boost Converter" *International Journal of Electrical and Computer Engineering (IJECE)*, Vol. 2, No. 3, June 2012, pp. 339~344, ISSN: 2088-8708.
6. T. Pan, M. C. Cheng, and C.M. Lai, "A novel integrated dc/ac converter with high voltage gain capability for distributed energy resource systems," *IEEE Trans. Power Electron*., Vol. 27, No. 5, pp. 2385-2395, May 2012.
7. Nami, F. Zare, A. Ghosh, and F. Blaabjerg, "Multiple-output DC–DC converters based on diode-clamped converters configuration: Topology and control strategy," *IET Power Electron*., Vol. 3, No. 2, pp. 197–208, 2010.
8. Rong-Jong Wai, Senior Member, IEEE, and Kun-Huai Jheng, "High-Efficiency Single-Input Multiple-Output DC–DC Converter" *IEEE TRANSACTIONS ON POWER ELECTRONICS*, Vol. 28, No. 2, FEBRUARY 2013.
9. Edwin van Dijk, Herman J. N. Spruijt, Dermot M. O'Sullivan, and J. Ben Klaassens "PWM-Switch Modeling of DC-DC Converters" *IEEE TRANSACTIONS ON POWER ELECTRONICS*, Vol. 10, No. 6, NOVEMBER 1995.
10. Leon M. Tolbert, Fang Zheng Peng, and Thomas G. Habetler, "Multilevel PWM Methods at Low Modulation Indices" *IEEE TRANSACTIONS ON POWER ELECTRONICS*, Vol. 15, No. 4, JULY 2000.
11. Muhammad Farrukh Yaqub, Muhammad Safian Adeel, and Tahir Izhar "Variable Voltage Source Inverter with Controlled Frequency Spectrum Based on Random Pulse Width Modulation" *International Journal of Power Electronics and Drive System (IJPEDS)*, Vol. 2, No. 2, March 2012, pp. 25-34, ISSN: 2088-8694.
12. P. Patra, A. Patra, and N. Misra, "A single-inductor multiple-output switcher with simultaneous buck, boost and inverted outputs," *IEEE Trans. Power Electron*., Vol. 27, No. 4, pp. 1936-1951, Apr. 2012.
13. D.Dhana Prasad, A.Krishna Veni, "Performance of Photovoltaic Assisted Five Level Diode Clamped Inverter fed Induction Motor", Volume: 2 | Issue: IJMTST 05 | April 2016 | ISSN: 2455-3778.
14. S. Flora Viji Rose, Mr. B.V. Manikandan, "Simulation and Implementation of Multilevel Inverter Based Induction Motor Drive", IEEE Xplorer, January 10, 2010.
15. www.irjet.net