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A Novel High Step up Matrix Converter with Phase Shifted Output

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Abstract: For boosting AC voltage step up transformer is required; an alternative solution for boosting AC voltage is power electronic converters. Conventional AC-AC converters cyclo and matrix converter does not have boosting capability. By adding inductive and capacitive passive elements and operating switches at high frequencies enables the boosting capability of matrix converters. This study presents a new high step up matrix converter with phase shifted output for AC applications. During low voltage scenario these types of converters are employed for applying constant voltage for appliances. A simple maximum boost PWM technique is employed for pulse generation of proposed high step up matrix converter. The proposed matrix converter can boost voltage in the ratio of 1:5. The proposed high step up matrix converter with phase shifted output is simulated in MATLAB/Simulink environment and results are presented to verify the merits of proposed scheme.

Key words: Step up, matrix converter, simple boost PWM technique, AC-AC converter, pulse, generation

INTRODUCTION

AC-AC converters are preferred for applications where frequencies other than grid frequencies are required. Matrix converter with AC voltage boosting capability is a great deal for low voltage AC sources like wind generators, generally wind mill will generate voltage in the range of three phase 24 V_{AC}. A high efficient single phase AC-AC matrix converter with both buck and boost capabilities is proposed by Ashraf *et al.* (2017). Literature of Chauhan *et al.* (2016) implemented a high voltage gain matrix converter but number of switches used is high compared to other conventional topologies. The conventional AC-DC-AC converters are replaced with boost type matrix converter for induction motor applications shows better voltage, torque and THD profile (Ahmed *et al*., 2017). Literature by Yang *et al.* (2015) presented two novel modulation schemes for Buck-Boost matrix converter, just by changing modulation index of modulation scheme high voltage gain can be achieved. Study of Song and Lin (2009) implemented a AC-DC and DC-AC boost matrix converter for AC applications. Modeling of Photovoltaic System with AC-AC converter topology for grid fed operations is presented by Umadevi *et al.* (2014). Design of a single input fuzzy logic controller based SVC for dynamic performance enhancement of power systems is discussed by Subramanian (2014).

MATERIALS AND METHODS

High step up matrix converter: Matrix converter performs a single stage AC-AC conversion whereas for converting AC-AC initially rectifier is used followed by inverter shows double stage conversion increasing converter size and cost. The proposed single-phase buck-boost Matrix converter consists of six unidirectional current flowing bidirectional voltage blocking switches, one inductor L and two input and output filter capacitors. The operation of this circuit as a conventional buck, boost and inverting buck-boost converters with voltage gain of D and 1/(1-D) and -D/(1-D) were given. Matrix converters are characterized by sinusoidal waveforms that show the input and output switching frequencies. Figure 1 shows the block diagram of proposed high step up converter.

The bidirectional switches make it possible to have a controllable power factor input. In addition, the lack of DC links ensures it has a compact design. The downside to matrix converters is that they lack bilateral switches that are fully controlled and able to operate at high frequencies. Its voltage ratio that is output to input voltage is limited.

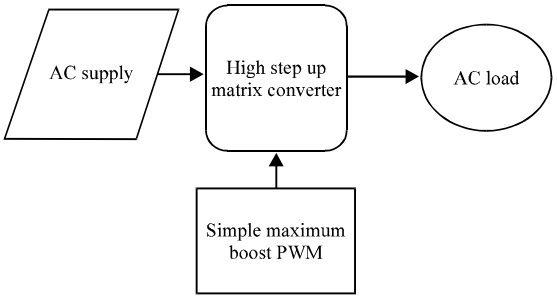

Fig. 1: Block diagram of proposed high step up matrix converter

RESULTS AND DISCUSSION

The proposed high step up matrix converter (AC-AC) is simulated in Simulink software and results are presented in this section. By varying the duty cycle command from 50-90% higher output voltage obtained in the range of 80-225 V. Table 1 shows various simulation parameters applied in proposed circuit and Table 2 shows the output voltage for 45 V input and different duty cycles. Figure 2 shows the AC input voltage for Duty cycle-70%, Fig. 3 shows the boosted AC output voltage for duty cycle-70%. Figure 4 shows the 180° phase shifted boosted AC output voltage. Figure 5 shows the AC input voltage for duty cycle-70%. Figure 6 shows the boosted AC output voltage for duty cycle-90%. Figure 7 shows the 180° phase shifted boosted AC output voltage.

Table 1: Simulation parameters

AC input voltage	45 (V)
Output voltage	Max. 225 (V)
Inductor L_1	800 (uH)
Capacitor C_1	1.5 (uF)
Power switch	Ideal switch
Load resistor	100 (Ω)

Table 2: Output voltage For 45 V input

Duty cycle (%)	Output voltage
50	60
70	85
80	145
90	225

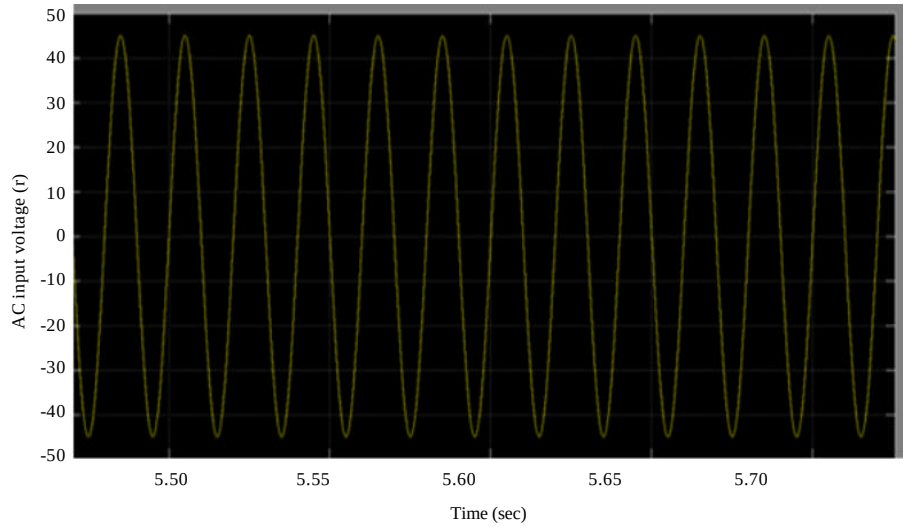

Fig. 2: AC input voltage for duty cycle = 70%

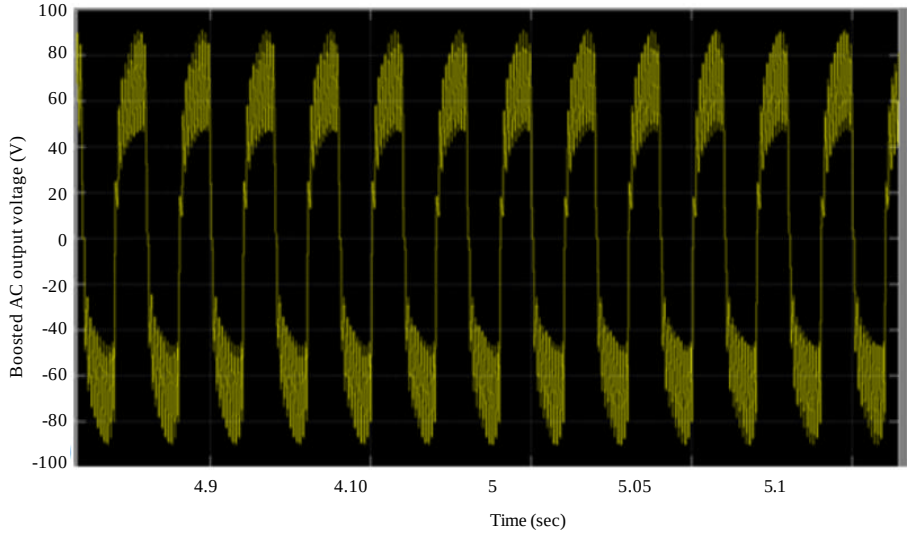

Fig. 3: Boosted ac output voltage for duty cycle = 70%

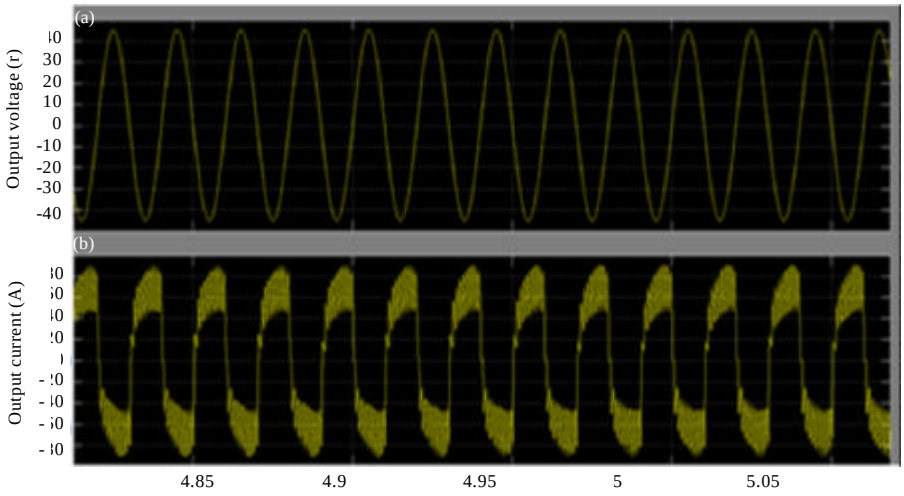

Fig. 4: a, b) 180° phase shifted boosted AC output

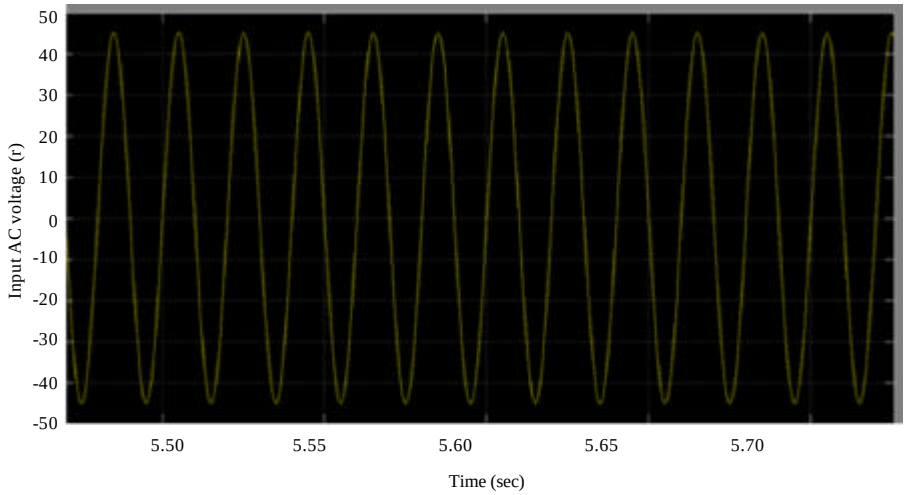

Fig. 5: AC input voltage for duty cycle = 70%

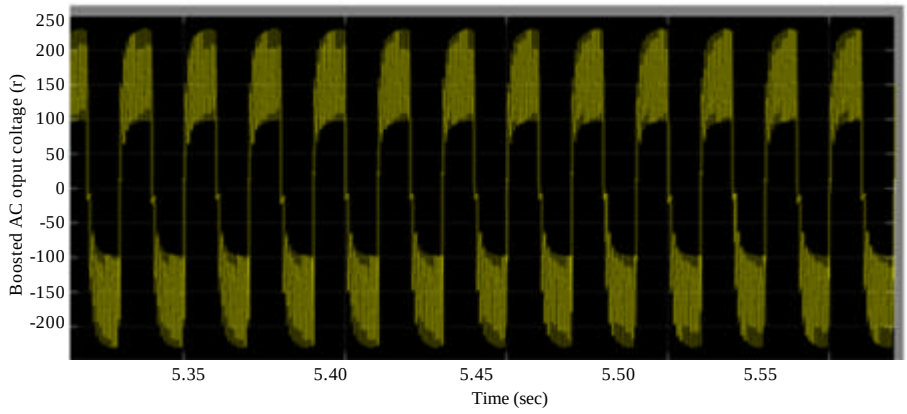

Fig. 6: Boosted AC output voltage for duty cycle = 90%

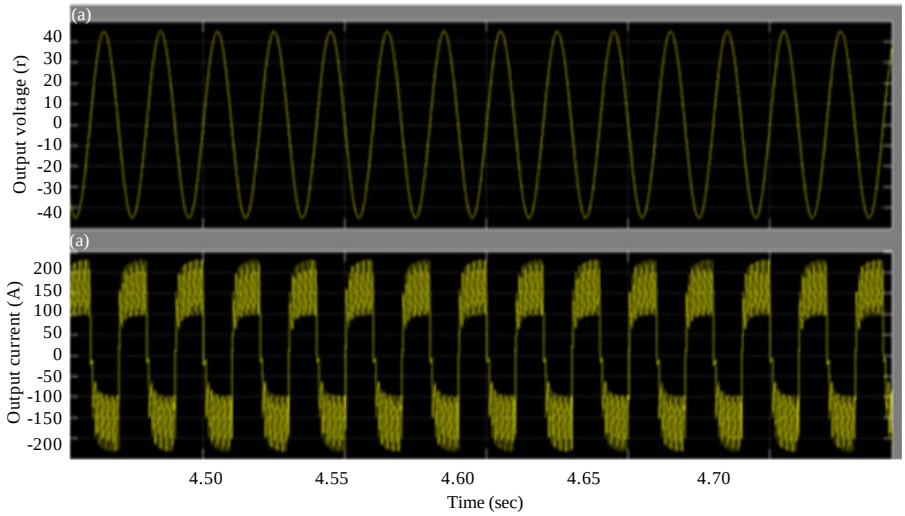

Fig. 7: a, b) 180° phase shifted boosted AC output

CONCLUSION

This study presented a new high step up matrix converter with phase shifted output for AC applications. During low voltage scenario these type of converters are employed for applying constant voltage for appliances. A simple maximum boost PWM technique is employed for pulse generation of proposed high step up matrix converter. The proposed matrix converter can boost voltage in the ratio of 1:5. The proposed high step up matrix converter with phase shifted output is simulated in MATLAB/Simulink environment and the results verify the merits of proposed scheme. AC input voltage can be boosted up to 220 V by using high duty cycle.

REFERENCES

Ahmed, H.F., H. Cha, A.A. Khan, J. Kim and J. Cho, 2017. A single-phase buck-boost Matrix converter with only six switches and without commutation problem. IEEE. Trans. Power Electron., 32: 1232-1244.

Ashraf, N., T. Izhar and G. Abbas, 2017. An efficient single-phase AC-to-AC buck and boost matrix converter. Proceedings of the 2017 International Conference on Electrical Engineering (ICEE), March 2-4, 2017, IEEE, Lahore, Pakistan, ISBN:978-1-5090-1241-1, pp: 1-5.

Chauhan, A.K., M.M. Reza, M. Raghuram and S.K. Singh, 2016. High gain buck-boost matrix converter. Proceedings of the 2016 IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES), December 14-17, 2016, IEEE, Trivandrum, India, ISBN:978-1-4673-8888-7, pp: 1-6.

Song, P. and J. Lin, 2009. A hybrid AC-DC-AC matrix converter with a boost circuit. Proceedings of the 9th International Conference on Electronic Measurement and Instruments ICEMI'09, August 16-19, 2009, IEEE, Beijing, China, ISBN:978-1-4244-3863-1, pp: 2-416-2-421.

Subramanian, D.D.P., 2014. Design of a single input fuzzy logic controller based SVC for dynamic performance enhancement of power systems. Intl. J. Eng. Technol., 6: 2342-2350.

Umadevi, K., P. Nalandha and C.C. Kesavan, 2014. Modelling of photovoltaic system with converter topology for grid fed operations. Intl. J. Eng. Technol. IJET., 6: 2392-2400.

Yang, J., Z. Xu, H. Han, L. Yu and M. Wen, 2015. Two novel modulation schemes for buck-boost matrix converter. Proceedings of the International Conference on Chinese Automation Congress (CAC), November 27-29, 2015, IEEE, Wuhan, China, ISBN:978-1-4673-7189-6, pp: 2158-2162.