Modelling and Simulation of Z Source Matrix Converter fed Induction Motor

V.Bindhu[1], J.Rubini[2]

Head of the Department, Dept. of EEE, Arunai Engineering College, Thiruvannamalai, Tamilnadu, India[1]

PG Student [PED], Dept. of EEE, Arunai Engineering College, Thiruvannamalai, Tamilnadu, India[2]

ABSTRACT: This project presents a single phase z-source buck-boost matrix converter which can buck and boost the output voltage with step change frequency i.e. both the voltage and the frequency can be stepped up or stepped down. Also, this converter uses a safe-commutation technique to conduct current in a continuous path, resulting in the elimination of voltage spikes on switches without the need for a snubber circuit. It has no energy storage devices, performing the energy conversion by directly connecting input with output phases through bidirectional switches. For this reason, it is known as all-silicon power converters. In the proposed scheme, micro controller is used to produce PWM signals. In particular it can be applied to the starting of an induction motor as well as to the speed control of an induction motor. The operating principles, analysis and experimental results of the proposed single phase z-source buck-boost matrix converter fed induction motor are implemented in Matlab / Simulink.

KEYWORDS: Buck–boost voltage, single-phase matrix converter, stepup and stepdown frequency, Zsource converter

I.INTRODUCTION

A matrix converter is an ac/ac converter that can directly convert an ac   voltage of constant amplitude into an ac voltage of variable amplitude and frequency without large energy storage element. The use of safe-commutation switches with pulse width modulation (PWM) control can significantly improve the performance of ac/ac converters. In this project work we apply the Z-source concept to a single phase matrix converter to create a new type of converter called a single phase Z-source buck-boost matrix converter. In contrast to the existing single phase PWM AC-AC converters, this proposed single phase Z-source buck-boost matrix converter can provide a wide range of output AC voltages in buck-boost mode with step up/step down frequencies. The safe commutation scheme establishes a continuous current path in dead time to eliminate voltage spikes on the switches without a snubber circuit. The proposed single-phase Z-source buck–boost matrix converter can be used for voltage applications that require step-changed frequency or amplitude. In particular, it can be applied to the starting of an asynchronous motor as well as to the speed control of an induction motor, which needs a step-changed speed. The various graphs/waveforms are analyzed and studied on MATLAB / SIMULINK.

II. PROPOSED SYSTEM

In this paper, we apply the Z-source concept to a single-phase matrix converter to create a new type of converter called a single-phase Z-source buck–boost matrix converter. We use a safe-commutation technique that is very simple to implement as a free-wheeling path to provide the required free-wheeling operation similar to what is available in other converter topologies. It also provides a continuous current path by using a commutation strategy. The use of this safe-commutation strategy is a significant improvement as it makes it possible to avoid voltage spikes on the switches without the use of a snubber circuit.

III.Z SOURCE CONVERTER

The Z-source converter (ZSC) is an alternative power conversion topology that can both buck and boost the input voltage using passive components. It uses a unique LC impedance network for coupling the converter main circuit to the power source, which provides a way of boosting the input voltage, a condition that cannot be obtained in

the traditional inverter. It also allows the use of the shoot-through switching state, which eliminates the need for dead-times that are used in the traditional inverters to avoid the risk of damaging the inverter circuit.
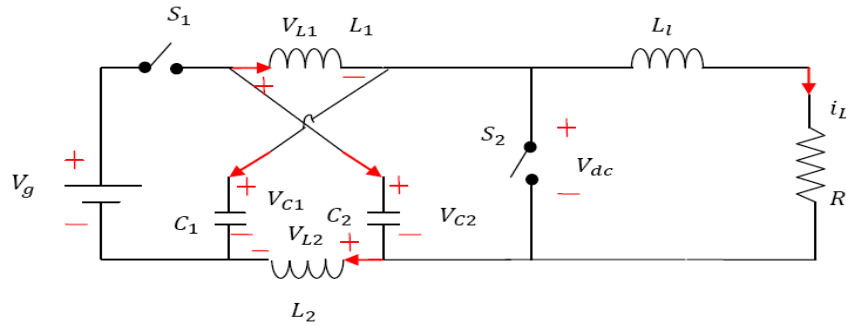

Fig 1 Circuit diagram of z source converter

STEADY STATE OPERATION OF ZSC

Operation of ZSC in continuous conduction mode (CCM) based on two states,
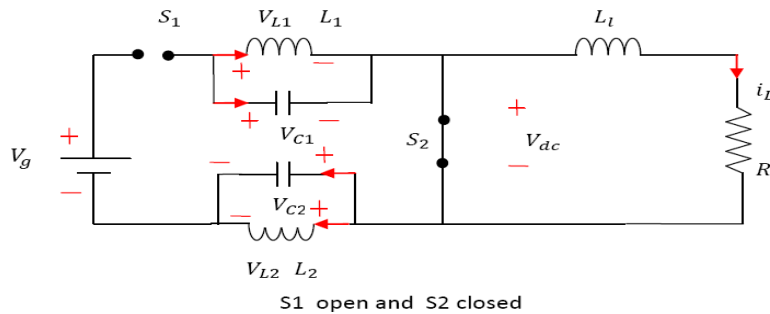1. Shoot-through state   (S2 is on & S1 is off)
2. Active state   (S1 is on & S2 is off)

SHOOT-THROUGH STATE

S1 open and S2 closed

Fig 2 circuit diagram for shoot-through state

For Z-source network to be symmetrical,

$$L_1 = L_2 \text{ and } C_1 = C_2$$
$$V_{C1} = V_{C2} = V_C \qquad and \qquad V_{L1} = V_{L2} = V_L$$

Let the converter is in the shoot-through state for an interval of *T0* during a switching cycle *T*,

$$V_L = V_C \qquad and \qquad V_{dc} = 0$$

ACTIVE STATE

Similarly, if the converter is in the active state for an interval of T1, during the switching cycle T,
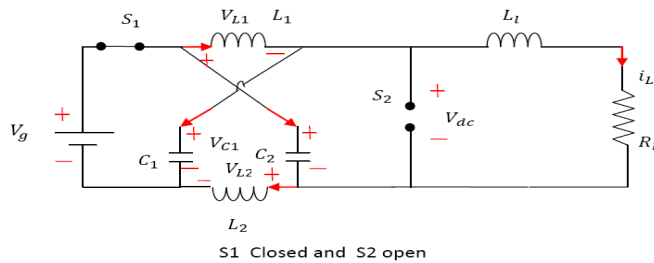
**Fig 3 circuit diagram for active state**

IV. MATRIX CONVERTER

Since no energy storage components are present between the input and output side of the matrix converter, the output voltages have to be generated directly from the input voltages. Each output voltage waveform is synthesized by sequential piecewise sampling of the input voltage waveforms. The sampling rate has to be set much higher than both input and output frequencies ,and the duration of each sample is controlled in such a way that the average value of the output Waveform within each sample period tracks the desired output waveform. As consequence of the input-output direct connection, at any instant, the output voltages have to fit within the enveloping curve of the input voltage system. Under this constraint, the maximum output voltage the matrix converter can generate without entering the over-modulation range is equal to v3/2 of the maximum input voltage: this is an intrinsic limit of matrix converter.

V.THE INPUT CURRENT

Likewise to the output voltages, the input currents are directly generated by the output currents, synthesized by sequential piecewise sampling of the output current waveforms. If the switching frequency of the matrix converter is set to a value that is much higher than the input and output frequency, the input currents drawn by the converter are sinusoidal their harmonic spectrum consists only of the fundamental desired component plus a harmonic content around the switching frequency.The matrix converter performance in terms of input currents represent a significant improvement with respect to the input currents drawn by a traditional VSI converters with a diode bridge rectifier, whose harmonic spectrum shows a high content of low-order harmonics. By the light of the standards related to power quality and harmonic distortion of the power supply this is a very attractive feature of matrix converter.
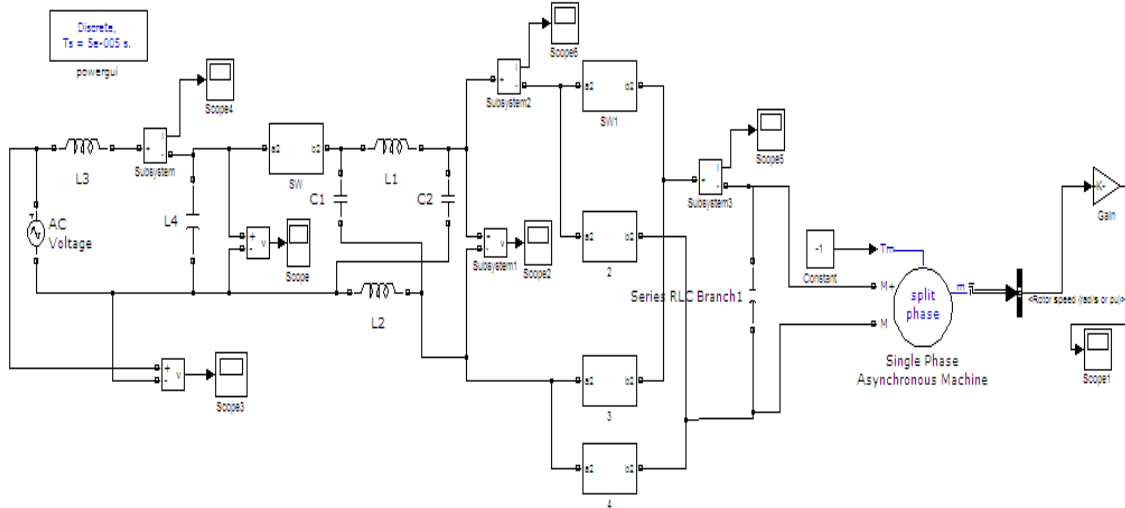
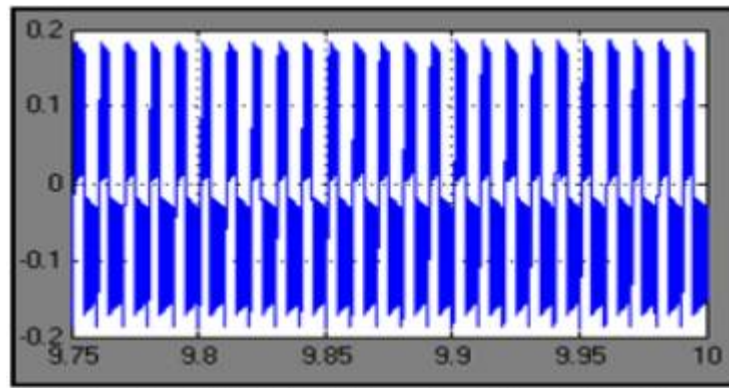## VI. SIMULATION RESULTS

BUCK OPERATION
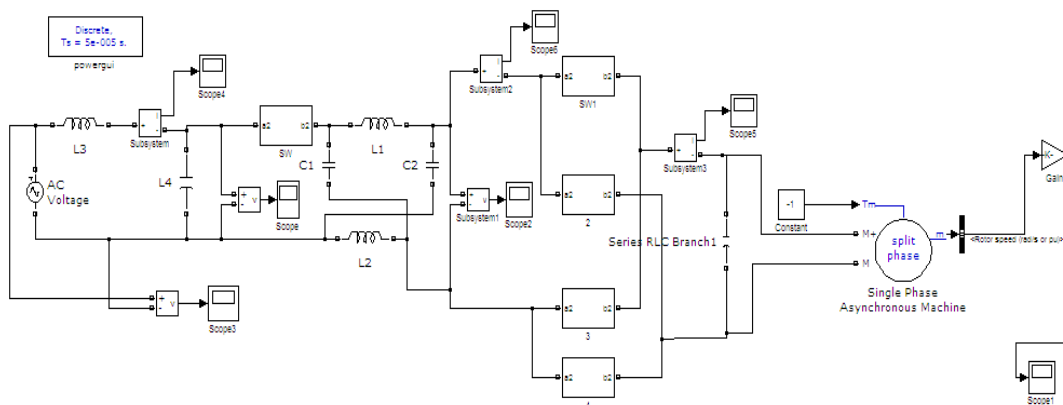
BOOST OPERATION

BOOST OPERATION OF Z SOURCE MATRIX CONVERTER VOLTAGE
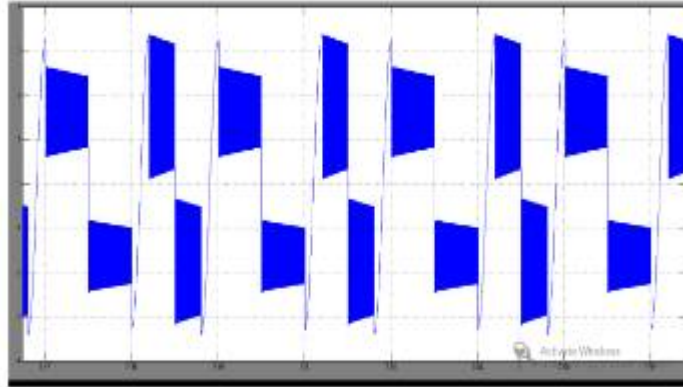

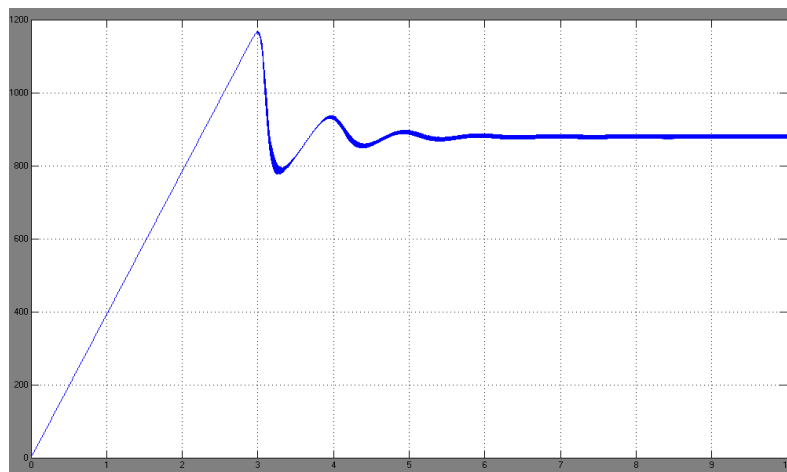### BOOST OPERATION OF Z SOURCE MATRIX CONVERTER CURRENT

BUCK OPERATION OF Z SOURCE MATRIX CONVERTER VOLTAGE

BUCK OPERATION OF Z SOURCE MATRIX CONVERTER CURRENT
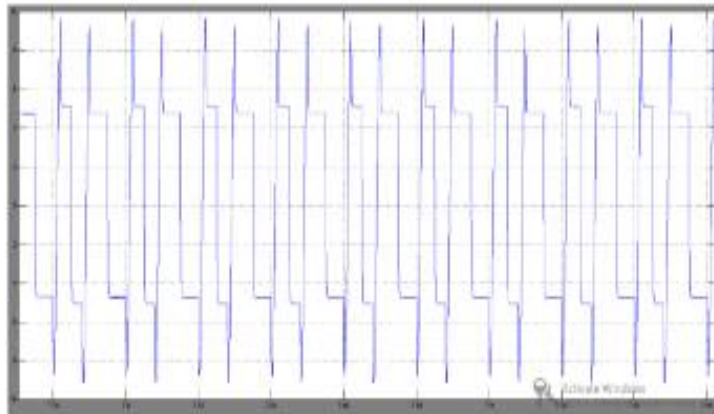
BOOST OPERATION OF Z SOURCE MATRIX CONVERTER SPEED

VII.CONCLUSION

In this project, a new Z-source Buck-Boost single phase matrix converter proposed that can buck and boost the input voltage to the desired output voltage. The proposed SPZMC can produce a boosted output voltage when compared with a normal matrix converter. The output voltage is boosted when there is change in pulse width of the switching frequency. The use of this safe-commutation strategy is a significant improvement as it makes it possible to avoid voltage spikes on the switches without the use of a snubber circuit. The proposed converter is particularly suitable for controlling the speed of a fan or a pump without the use of an inverter because for these applications, the input voltage frequency must be changed to control their speed by stages.

REFERENCES

[1] Siinter and O. Aydogmus, "Modelling and simulation of matrix converter induction motor drive, "Springer Electr. Eng., vol. 90, no. 6,pp. 425–433, 2012

[2] A. Zuckerberger, D. Weinstock, A. Alexandrovitz, "Single -phase matrix converter," IEE Proceedings Electric Power Application, Vol. 144 (4), Page(s): 235-240, Jul2013

[3] X. P. Fang, Z. M. Qian, and F. Z. Peng, "Single-phase z-source PWM ac-ac converters,"IEEE Power Electron. Lett., vol. 3, no. 4, pp. 121–124,2013.

[4] P. C. Loh, R. Rong, F. Blaabjerg, and P.Wang, "Digital carrier modulation and sampling issues of matrix converters," *IEEE Trans. Power Electron.*, vol. 24, no. 7, pp. 1690–1700, Jul. 2009.

[5] Y. D. Yoon and S. K. Sul, "Carrier-based modulation technique for matrix converter," *IEEE Trans. Power Electron.*, vol. 21, no. 6, pp. 1691–1703, Nov. 2006.

[6] M. Jussila and H. Tuusa, "Comparison of simple control strategies of space-vector modulated indirect matrix converter under distorted supply voltage," *IEEE Trans. Power Electron.*, vol. 22, no. 1, pp. 139–148, Jan. 2007.

[7] I. Sato, J. Itoh, H. Ohguchi, A. Odaka, and H. Mine, "An improvement method of matrix converter drives under input voltage disturbances," *IEEE Trans. Power Electron.*, vol. 22, no. 1, pp. 132–138, Dec. 2011.