A MATRIX CONVERTER PRODUCING TWO PHASE SUPPLY FROM SINGLE PHASE SUPPLY

[1]TRUPTI.L.BONDE, [2]R.M.MOHORIL, [3]A.Y.FADNIS, [4]PRACHI M. PALPANKAR

[1,2,3]Stud. Department of Electrical Engineering Y.C.C.E Wanadongri, Nagpur
[4]Department of Electrical Engineering DBACER Wanadongri, Nagpur
Email: trupti_bonde@yahoo.com, mm_ycce_ep@yahoo.com, ayfadnis@gmail.com, prachi_bd22@yahoo.com

Abstract-This paper describes a matrix converter which gives a two phase supply as an output. The said matrix converter is devoid of any energy storage element. This output is used for running two phase induction motor.

Keywords— two phase matrix converter, Control strategies, Modulation schemes.

I. INTRODUCTION

As shown in figure 1. matrix converter is ac to ac converter, which is also called as direct energy conversion. The direct AC/AC converter provides a direct connection between the input and output terminals without an intermediate energy storage element through an array of semiconductor switches. It has an array of m×n bidirectional power switches to connect an m phase voltage source to a n phase load. The matrix converters which are prevalent in the industry are basically designed for three phase induction motor. The industry driven three phase motor requires converter system or a matrix converter. The converter-inverter requires the smoothing capacitors. The smoothing capacitor ages with temperature and time.

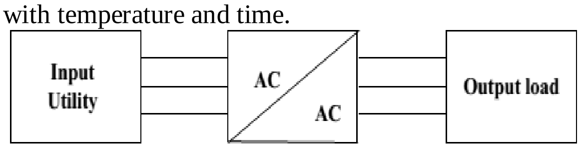

fig.1. Direct power conversion

In this paper we propose a novel single to independent two phase matrix converter d evoid of any reactive element. It also proposes a simple control algorithm of the bidirectional switches.

II. CIRCUIT CONFIGURATION

Figure 2. Shows the circuit configuration of single to two phase matrix converter no capacitor or Inductor is required. Each bidirectional switch consists of two diodes and two transistors.

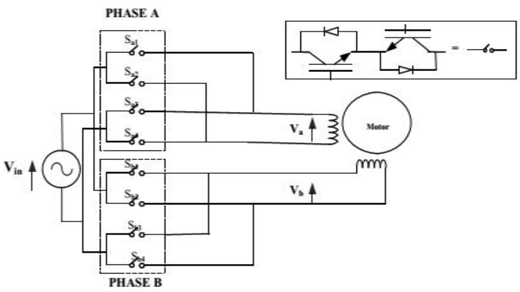

Fig.2.Configuration Of Single Phase To Two Phase Matrix Converter

The switches S_{a1}, Sa_2, Sa_3, Sa_4 from phase A and S_{b1}, Sb_2, Sb_3 and S_{b4} from phase B. The switches from the two phase.

III. CURRENT DIRECTION FOR PHASE A

When switch S_{a1} and S_{a4} are conducting for phase A and in same time S_{a2} and S_{a3} are off as shown in figure 3(a).

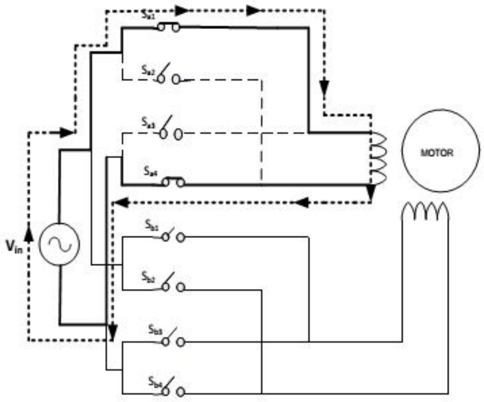

fig 3(a1):- Switching Diagram for Phase A
S_{a1} and S_{a4}=ON

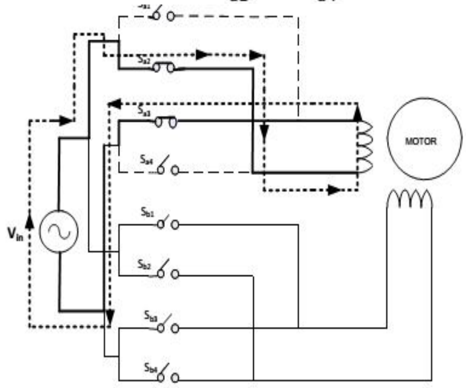

fig 3(a2):- Switching Diagram for Phase A
S_{a2} and S_{a3}=ON

When S_{a2} and Sa3 are ON than S_{a1} and S_{a4} is not conducting as shown in figure 3(a2).

IV. CURRENT DIRECTION FOR PHASE B

Similar operation down for phase B. As shown in figure 3(b1 and b2). Where only two switches are operated at one conduction for phase B.

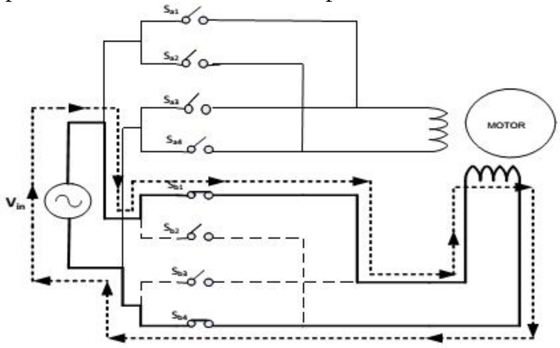

Fig 3(b1):- Switching Diagram for Phase B
S_{b1} and S_{b4}= ON

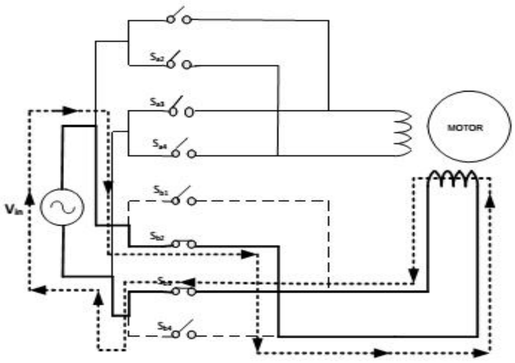

Fig 3(b2):- Switching Diagram for Phase B
S_{b2} and S_{b3}= ON

V. DEVELOPMENT OF CONTROL ALGORITHM

Figure 3 and 4. Shows the relation of the input and output voltage reference, the actual output, and the switching pattern of phase A.

The voltage V_{in} , $V_{ref\ a,}$ $_{Vref\ b}$ are defined as follows.

V_{in}=V_i sin (w_it)................................ (1)

$V_{ref\ a}$= V_o sin ($w_o t+\frac{\pi}{4}$)......................... (2)

$V_{ref\ b}$= V_o sin ($w_o t- \frac{\pi}{4}$)..........................(3)

The two phase voltage specified by reference voltage $V_{ref\ a}$ and $V_{ref\ b}$. Input voltage frequency and output voltage frequency are defined as w_i=2Πf$_i$ and w_o=2Πf$_o$, respectively. The phase difference of reference to V_{in} are set to $\pm\frac{\pi}{4}$. So that $V_{ref\ a}$ + $V_{ref\ b}$= V_{in} holds if f_o= f_i and $V_o=\frac{1}{\sqrt{2}}V_i$ as shown in figure 3.

VI. ALGORITHM TO CONTROL SWITCHES

1] In case $|V_{ref\ a}|<|V_{in}|$ (mode II & mode III as shown in fig.3.), Keep $V_a=V_{ref\ a}$ with buck conversion from V_{in} or $-V_{in}$.

2] In case $|V_{ref\ a}|\geq|V_{in}|$ (mode I & mode IV in fig.3.) Keep $V_a=V_{in}$ or $V_a= -V_{in}$ .So as to be the same as $V_{ref\ a.}$

Signs of two parameters $V_{ref\ a}\times V_{in}$ and $|V_{ref\ a}|-|V_{in}|$ as sufficient to determine the switching mode of eight bidirectional switches S_{a1}, Sa_2, Sa_3, Sa_4 from phase a and S_{b1}, Sb_2, Sb_3 and S_{b4} from phase b as defined in table I and II respectively. The switching modes of Sa_3 and Sa_4 are defined as inverted owes of Sa_1 and Sa_2 respectively, to make continuous loops in circuit for fly-back current of the motor.

Table I:-Switching table for phase A

MODE	I	II	III	IV
$\|V_{ref,a}\|\times\|V_{in}\|$	+	+	-	-
$\|V_{ref,a}\|-\|V_{in}\|$	+	-	-	+
S_{a1}	ON	PWM	OFF	OFF
S_{a2}	OFF	OFF	PWM	ON
S_{a3}	OFF	PWM	ON	ON
S_{a4}	ON	ON	PWM	OFF

Waveform For Phase A:-

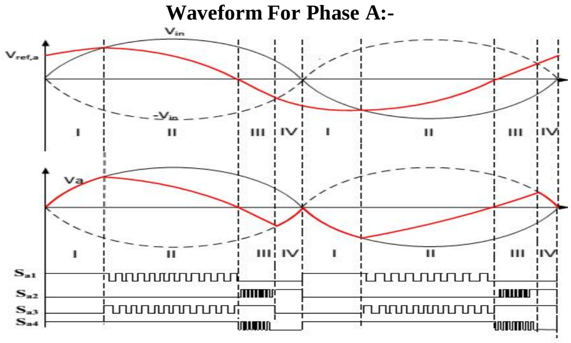

Figure 3. Relation between input and output for phase A

Table II
Switching Table For Phase B:-

MODE	I	II	III	IV
$\|V_{ref,b}\|\times\|V_{in}\|$	-	+	+	-
$\|V_{ref,b}\|-\|V_{in}\|$	-	-	+	+
S_{b1}	ON	PWM	OFF	OFF
S_{b2}	OFF	OFF	PWM	ON
S_{b3}	OFF	PWM	ON	ON
S_{b4}	ON	ON	PWM	OFF

Waveform For Phase B:-

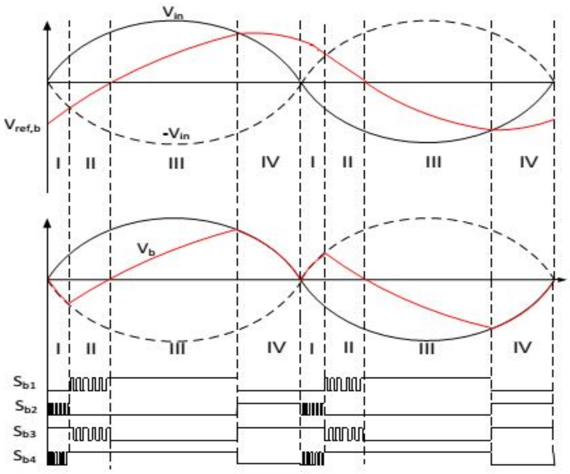

Figure 4. Relation between input and output for phase B

VII. SIMULATION PARAMETERS

TableI II:-

PARAMETERS	RATING
Supply Voltage (Vin)	Vin, rsm=60V
Reference Voltage (Vref a, Vref b)	$V_o=V_{in}/\sqrt{2}$
Frequency (Hz)	50Hz
RL Load	R=1.6Ω,L=20mH
PWM Switching frequency	1KHz

VIII. SIMULATION MODEL

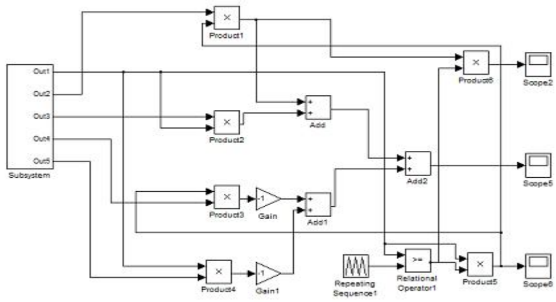

Fig. 6. Blocks connected for simulation of voltage Of Inverter and the simulated waveform.

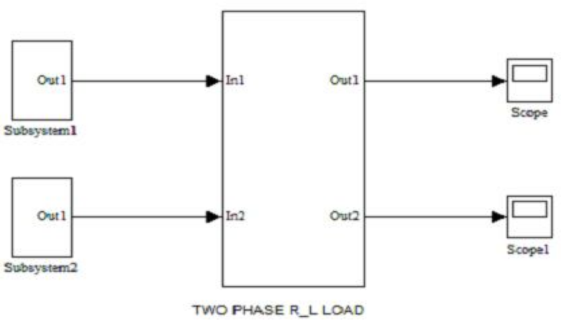

Fig.7.Blocks connected for simulation of RL load current. Fig.6. and Fig.7 represent the inverter output voltage and load current respectively.

IX. SIMULATION RESULT

A] Simulation Result for phase A:-

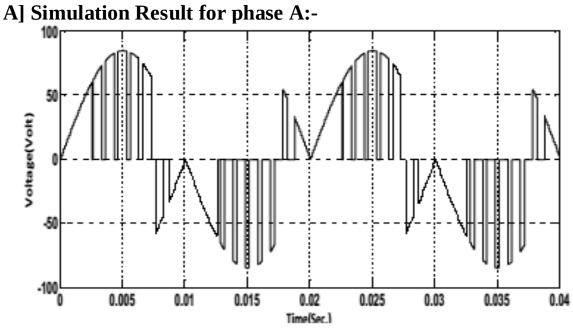

Figure.8 (a).Voltage for Phase A (F=50Hz)

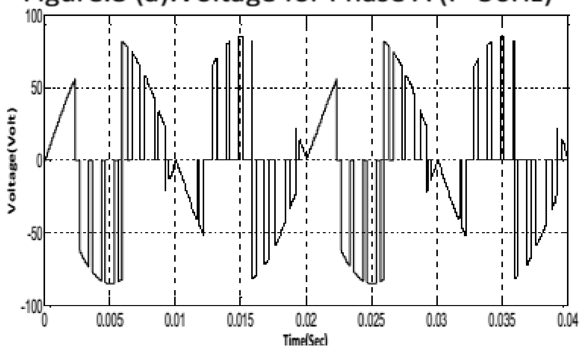

Figure.8 (b).Voltage for Phase A (F=150Hz)

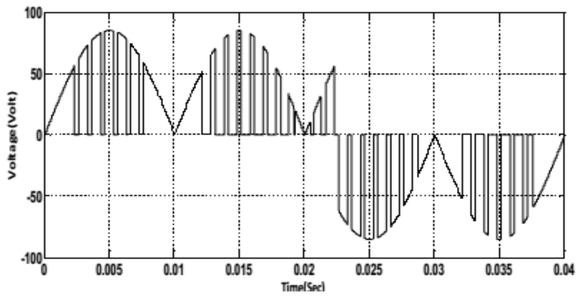

Figure.8 (c).Voltage for Phase A(F=16.66Hz)

B] Simulation Result for phase B:-

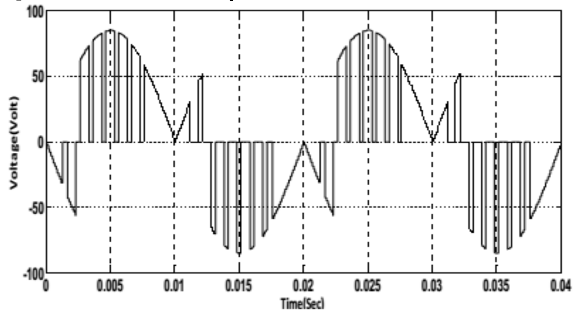

Figure.9 (a).Voltage for Phase B (F=50Hz)

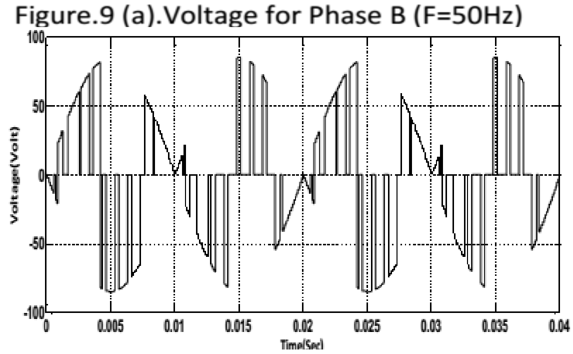

Figure.9 (b).Voltage for Phase B (F=150Hz)

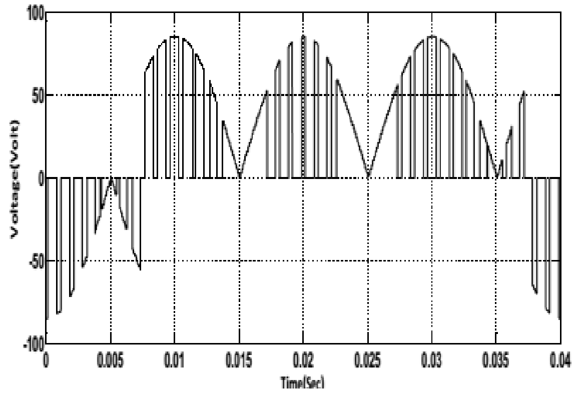

Figure.9 (c).Voltage for Phase B (F=16.67Hz)

C] Simulation result for RL Load

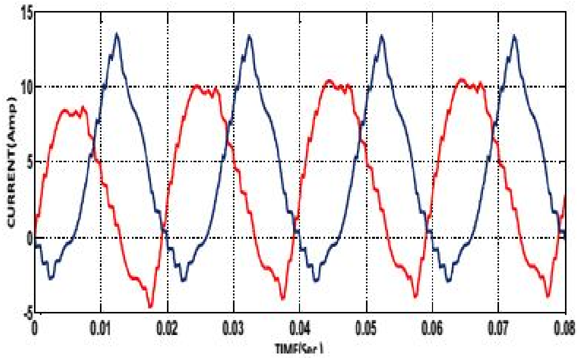

Fig.10(a).load current for frequency =50Hz

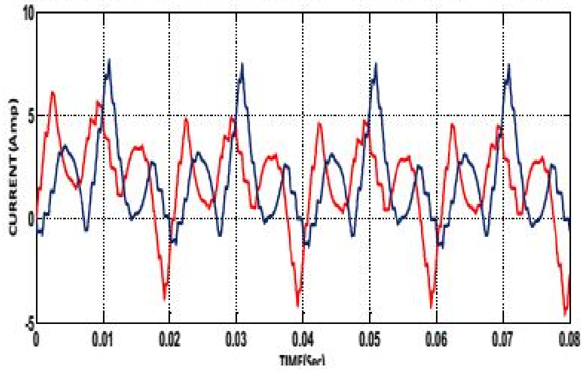

Fig.10(b).load current for frequency =150Hz

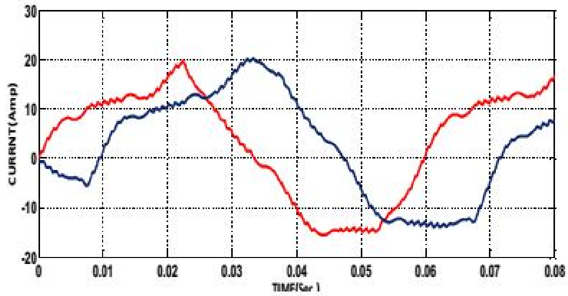

Fig.10(C).load current for frequency =16.67Hz

CONCLUSION

A Two phase supply is generated from single phase matrix converter .The importance of the circuit is empharied by a simple algorithm used. The circuit is avoiding of any reactive element and can used where single phase supply is available.

REFERENCES

[1] Yuji Kudoh, Nobuyuki Otsuka and Kenji Mizutani,“ A Novel Single to Two-Phase Matrix Converter for Driving A Symmetrically Designed Two-Phase Induction Motor,”IEEE,pp 1133-1138,2013.

[2] Jose Rodriguez, Marco RiveraJohan and W. Kolar, “A Review of Control and Modulation Methods for Matrix Converters,” IEEE transactions on industrial electronics, Vol. 59, No. 1, January 2012.

[3] M.Rameshkumar ,Y.Sreenivasa Rao and A.Jaya Laxmi, “Modulation and Control techniques of Matrix converter,” International journal of Advance engg,Vol-4,pp.244-255,July2012.

[4] Sangshin Kwak and Hamid A.Toliyat, “Development of modulation strategy for two-phase AC-AC Matrix converter,”IEEE transaction on energy conversion ,Vol.20,No.20,june 2005.

[5] M.Asgar,S.Mansourpour,E.Afjei,“Matrix converter for two-phase induction motor

[6] application:Analysis,Modeling and simulation”, second power electronics, Drive system and technologies conference ,pp-246-250,2011.

[7] G. Milan, M. Mohamadian, E. Seifi, and S.M. Dehghan, “A novel minimized switch two-phase matrix converter for driving two-phase induction motor,” PEDSTC, pp. 7-12, 2012.

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