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Single Phase to Single Phase Matrix Converter Fed Induction Motor Drive

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ABSTRACT

The aim of the project is to improve the performance of a single-phase matrix converter fed induction motor. Normally the variable AC voltages are achieved in two stages using PWM VSI. Nowadays MCs replace VSI, because of its regeneration capability, four quadrant operations and direct AC-AC conversion without DC link. In the present work SPMC is modelled and simulated using MATLAB Simulink. Sine PWM technique is used for controlling output voltage. Switching spikes generated are reduced with simple commutation technique and THD analysis of source current is carried out with the proposed commutation technique. Conversion of 50Hz-25Hz and 50Hz-100Hz are achieved and the simulation result shows that the spikes are reduced.

Keywords : Index Terms-BDS, Commutation Principle, SPMC, SPWM

I. INTRODUCTION

Single-phase cyclo-converters are used for AC-AC power conversions, particularly for speed control of AC drives. In a cyclo-converter, the AC power at one frequency is converted directly to another frequency generally lower than the input supply frequency without any intermediate DC stage. The Single-Phase Matrix Converters (SPMC) can replace the same operation of cyclo-converters, but with wide range of varying frequency may be lesser or higher than the input frequency. A typical converter consists of one or more pairs of back-to-back connected rectifiers. The SPMC consists of a matrix of input and output lines with four Bidirectional Switches (BDS) connecting the single-phase input to the single-phase output at the intersections.

II. SPMC TOPOLOGY

The SPMC is presented schematically in the figure 1. Its instantaneous input voltage is v1 (t) and its output voltage is v0 (t). It comprises of four ideal switches S1, S2, S3, S4 capable of conducting current in both directions, blocking forward and reverse voltages (symmetrical devices) and switching between states without any delays.

This topology converts the input voltage, vi (t) which constant amplitude and frequency, through the four ideal switches to the output terminals in accordance with the pre calculated switching angles. The input voltage is given by

vi (t)= 2vi cos w it

vi (t)=input voltage of SPMC

wi(t)= input angular frequency

The MC will be designed and controlled in such a manner the fundamental of output voltage is

Vo (t)= 2 Vo cos w0 (t)

Vo (t)= output voltage SPMC

Vo(t)= output angler frequency of SPMC

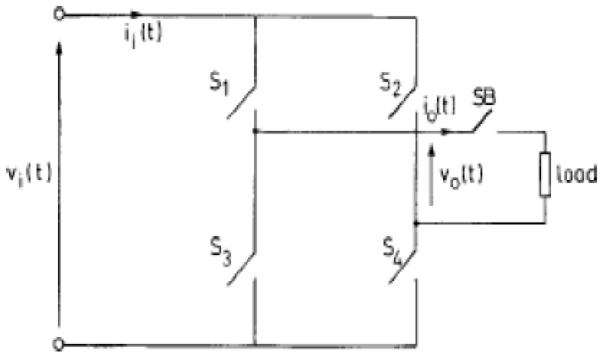


Figure 1 : Circuit Diagram of SPMC

The four switches are S1, S2, S3, S4 are the BDS it this each switch are classified as forwarded conducting switch a and reverse conducting switch b. thus based on this 24=16 switching combinations are possible but out of these 16 combinations only four combinations can be applied to the converter based on table 1. the four switching states of SPMC are given in table 1.

Switching state	Conducting switch	Conducting period	Load terminal voltage
1	1a,4a	Vi(t)	Vo
2	1b,4b	-Vi(t)	-Vo
3	2b,3b	Vi(t)	Vo
4	2a,3a	-Vi(t)	-Vo

Table 1: Switching States

SIMULINK MODEL OF SPMC

The SPMC circuit is simulated using MATLAB/Simulink. SPMC is developed as shown in figure 2 the BDS are modelled using the IGBT models available sim power system block. The triggering pulses are generated by SPWM technique which is shown as the separate sub system.

III. SWITCHING STRATEGY

The entire operation of SPMC can be explained in four states. For realizing any output frequency, the modes of operation is same. The frequency of the converter is changed by controlling the duration of conduction of the switch. Here the input given is 50 Hz and the desired output frequency synthesized is lower frequency like 25Hz and higher frequency like 100Hz extra.

The switching angles, of the four BDS sij (i=1,2,3,4j=a, b) where a and b represent as a driver 1 and driver 2 respectively

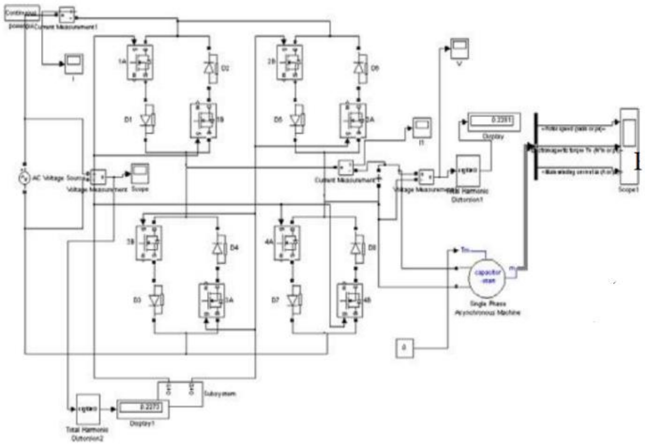


Figure 2: Simulink Model

State 1: At any time, t, only two switches sij (i=1,4 and j=a) will be in on state and conduct the current flow during positive cycle of input source. Hence the output voltage is positive

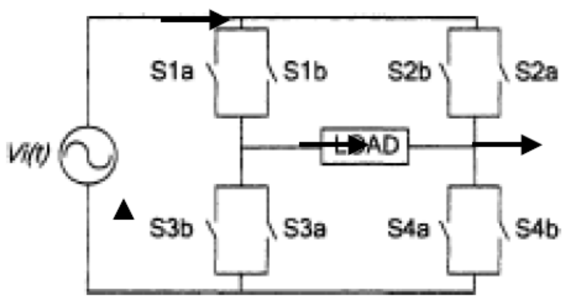


Figure 3: switching state 1 (positive cycle)

State 2: At any time, t, only two switches sij (i=1,4 and j=b) will be in on state and conduct the current flow during negative cycle of input source. Hence the output voltage is negative.

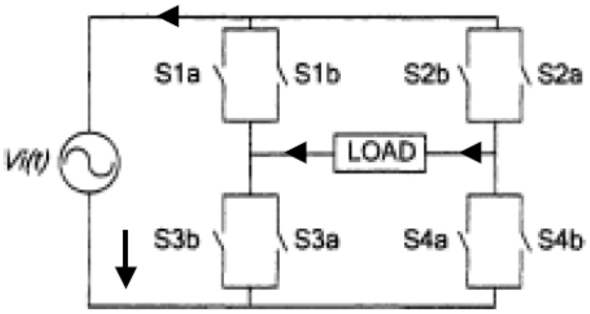


Figure 4 : switching state 2 (negative cycle)

State 3: At any time, t, only two switches sij (i=2,3 and j=b) will be in on state and conduct the current flow during negative cycle of input source. Hence the output voltage is negative

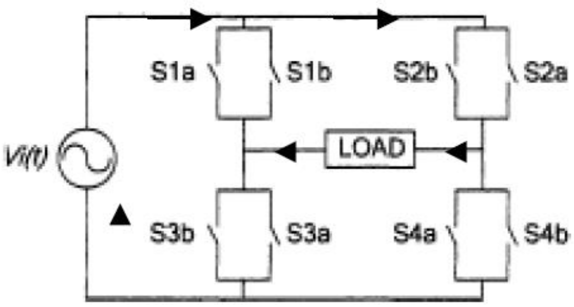


Figure 5: switching state 3 (Negative cycle)

State 4: At any time, t, only two switches sij (i=2,3 and j=a) will be in on state and conduct the current flow during cycle negative of input source. Hence the output voltage is positive

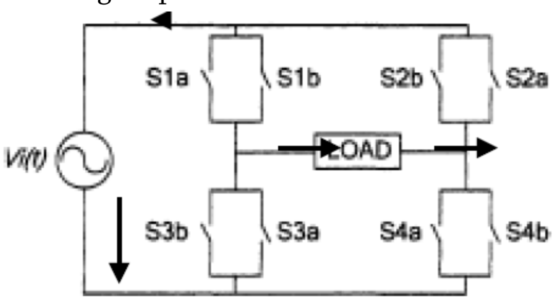


Figure 6: switching state 4 (positive cycle)

IV.MODULATION TECHNIQUE

Out of many modulating techniques sine PWM technique is used in the present work. Sinusoidal pulse width modulation (SPWM) is a well-known wave shaping technique. For realization, high frequency triangular carrier signal, Vc is compared with a sinusoidal reference signal, V reference of, desired frequency. The crossover points are used to determine the switching instant.

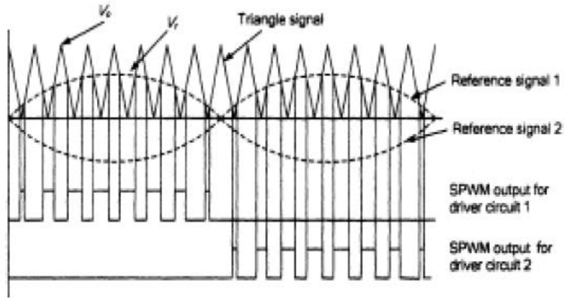


Figure 7: Sine PWM Generation

Sine PWM pulses are generated by comparing sinusoidal reference signal with triangular carrier wave of frequency fc as shown in figure 7 the frequency of reference signal fr determines output frequency f0 and its peak amplitude Ar controls the modulation index mi. by changing mi from 0- 1 the RMS value of the output voltage vo is varied from V01.

The magnitude ratio of the reference signal Vf to that of triangular signal Vr is known as modulation index mi. the magnitude of fundamental component of output voltage is proportional to mi. the amplitude Vs of the triangular signal is generally kept constant. By varying the modulation index, the output voltage can be controlled. The pulses required are generated by using sign PWM logic.

Input Frequency	Output Frequency	Time Interval	State	Switch "ON"	Commutation Switch "ON"
50 Hz	50 Hz	1	1	S1a & S4a	S2a
		2	2	S1b & S4b	S2b
	100 Hz	1	1	S1a & S4a	S2a
		2	3	S2b & S3b	S1b
		3	4	S2a & S3a	S1a
		4	2	S1b & S4b	S2b
	150 Hz	1	1	S1a & S4a	S2a
		2	3	S2b & S3b	S1b
		3	1	S1a & S4a	S2a
		4	2	S1b &S4b	S2b
		5	4	S2a & S3a	S1a
		6	2	S1b & S4b	S2b

Table 2 : Sequence of Switching Control with Safe Commutation Principle

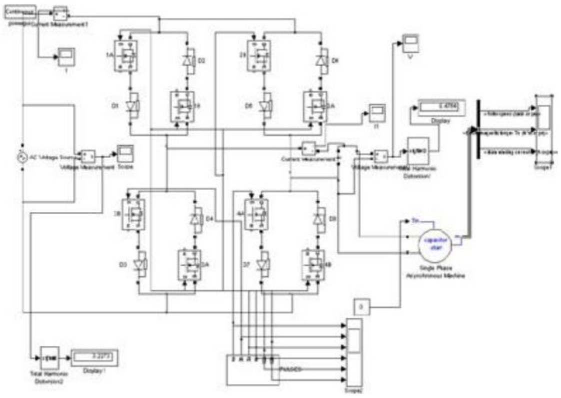


Figure 8: Simulink model with commutation principle

V. SIMULATION RESULTS

Single Phase Matrix convertor is Connected to single phase induction motor with Sine PWM technique and simulation results are shown below

A. Parameters of Circuit

Circuit parameters
I/P source= 230*1.414, 50Hz
O/P load: induction motor = 0.25*746KW, 230v, 100Hz

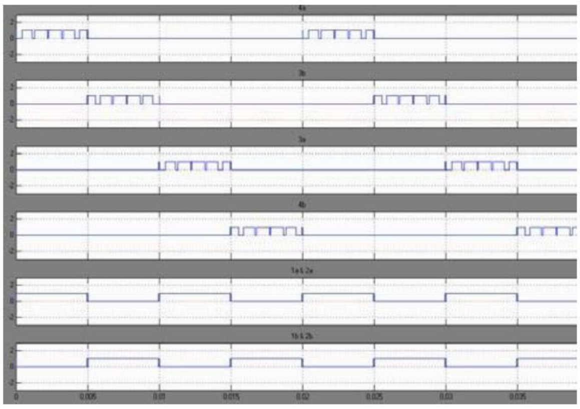
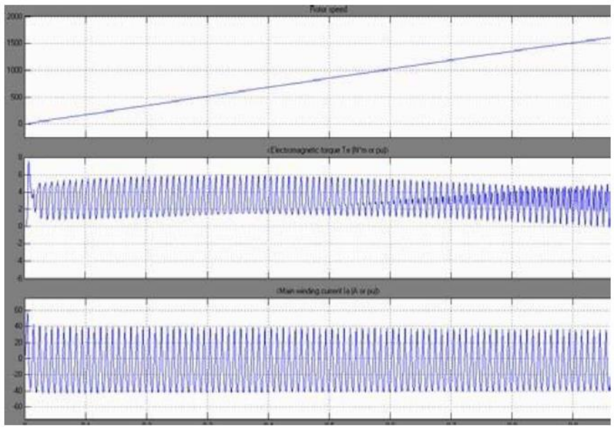
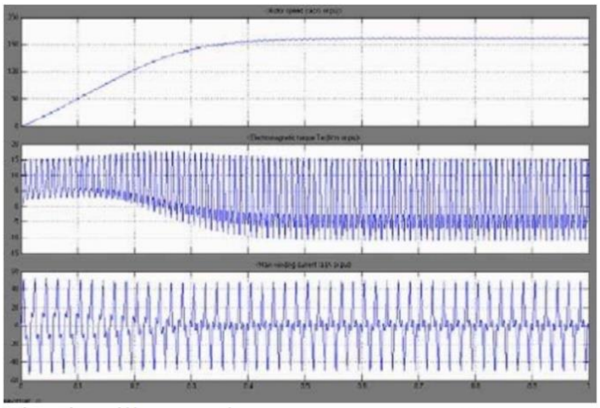


Figure 9 : Sine PWM triggering Pulses for 100 Hz.



Time in mille seconds

Figure 10 : output for 100Hz of sine Pwm triggered SPMC with commutation strategy Input 50Hz & output 100Hz:



Time in mille seconds

Figure 11 : output for 100Hz of sine PWM triggered SPMC without commutation strategy Input 50Hz & output 100Hz:

VI. CONCLUSION

The analysis of SPMC with SPWM switching technique is done. Frequency control is done with these switching strategies. The simulation results are also up time. Converter when triggered with the sine PWM pulses the current becomes discontinues and voltage spikes are appearing so the pulses are modified such a way that any of the switches will conduct every time so that open circuit is avoided and the current becomes continues and voltage spikes are also reduced. Simulation results of single-phase induction motor are also obtained from the simulation results shown one can conclude that voltage spikes are reduced analysis are shown in Table 3.

Parameters	With Commutation Principle
ITHD (IN)	22%
ITHD (OUT)	46%

Table 2 : Results

VI. REFERENCES

[1]. L. Zhang, C.Watthansaran, W.Shepherd (1995), "A Novel Switch Sequencer Circuit for Safe Commutation of A Matrix Converter", Electron Lett, 31, (18), pp. 1530- 1532.

[2]. Zahirrudin Idris Mustafar Kamal Hamaz, (2005), "Modeling & Simulation of a New Single-Phase to Single Phase Cycloconverter Based on Single Phase Matrix Converter Topology with Sinusoidal Pulse Width Modulation Using Matlab/Simulink", IEEE PEDS

[3]. Zahirrudin Idris, Mustafar Kamal Hamaz, Mohammad Fadzil Saidon, "Implementation of Single Phase Matrix Converter as a direct AC-AC Converter with Commutation Strategies", IEEE PEDS

[4]. Azharuddin Idris, Siti Zabiha Mohammad Noor, Mustafa Kamal Hamaz (2005), "Safe Commutation Strategy in Single Phase Matrix Converter" IEEE PEDS 2005 pp. 886- 891.

[5]. Zuckerberg, A, Weinstock, D, Alexandro Vitz, (1997), "A Single-Phase Matrix Converters" IEEE PROC Electric Power App vol. 144, 4 July, pp. 235-240.

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