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Speed Control of 1 ϕ Induction Motor Using 1 ϕ Matrix Converter

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Abstract : This paper is about design of 1 ϕ Matrix Converter (SPMC) topology for AC-AC conversion with frequency being unchanged. The circuit comprises of four ideal switches and used as either step up or step down converter. Bi-directional energy flow capability is the main advantage. Sinusoidal Pulse Width Modulation (SPWM) technique utilized to synthesize output. The pace of the induction motor can be controlled by using Matrix converter (MC). In this paper we are going to implement MC as a Cyclo converter, thereby controlling the speed of the motor also. The MATLAB/ Simulink (MLS) has been used.

Keywords : Sinusoidal Pulse Width Modulation (SPWM), Matrix Converter (MC), Cyclo converter.

1. INTRODUCTION

The Matrix Converter (MC) tenders hypothetical result to AC-AC conversion, thereby eliminating the obligation of energy storehouse elements. Bi-directional energy flow capability is the main advantage of MC.

Conventionally Insulated Gate Bi-polar Transistor (IGBT) is preferred over others because of switching commutation. The MC cartography has been restrained due to innate inhibitions that were absence of natural freewheeling path. Thus commutation scheme established the current pathway energy to train during the dead time, thereby preventing the voltage spikes. The single phase matrix converter (1 ϕ MC) required for 4 bi-directional switches are adapted to conduct current in both directions and bar voltages in both leading and reversal directions. The Sinusoidal Pulse Width Modulation (SPWM) technique has been used to produce the output voltage. In SPWM triangular carriers signal (VC) and sinusoidal reference signal (V_{ref}) are compared and the ratio of V_{ref} to V_c is acknowledged as Modulation Index (MI). The output voltage can be controlled by varying the modulation index (MI) by maintaining Vc as constant.

2. MATRIX CONVERTER

Converter gets its name as Matrix Converter name because in this converter the energy storage elements are arranged in Matrix form. The matrix converters are preferred over other converters because of several reasons. Some of them are listed as : (*a*) Contributes sinusoidal input and output waveforms, with least possible higher order harmonics and no sub harmonics. (*b*) Inbuilt energy flow capability in both directions thereby controlling the input power factor. (*c*) Minimum requirement of energy storehouse elements thereby eliminating the need of hulking and bounded energy cumulating capacitors. Along with all these advantages the MC's has detriment also. Some of them are mentioned as : (*a*) Maximum input-

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output voltage transfer ratio limited to 87% for sinusoidal input and output waveforms. (*b*) Requires more semiconductor devices than conventional converters, because bi-directional switches do not exist and discrete unidirectional devices are arranged to form a bi-directional switch. (*c*) It is sensitive to the disturbances of the input voltage system.

Matrix converter can be used as any type of converter as Cyclo converter, rectifier, inverter, AC voltage controller. Based on our application we can use as any type of converter.

Generally matrix converters are of two types :

1. Direct Matrix Converter.
2. Indirect Matrix Converter.

In direct matrix converter AC voltage is transformed to changeful AC voltage along with frequency. There is no need of energy storage elements, rectifier-inverter circuit in direct matrix converter. Voltage can be converted directly.

In Indirect Matrix Converter first the AC voltage is converted to DC with the help of rectifier after that it is again converted to AC voltage with the help of Inverter. Direct matrix converter is advantageous than indirect matrix converter.

3. 1 ϕ MATRIX CONVERTER (1 ϕ MC)

Transfer of energy from source to load employing MC is shown in Fig 1.

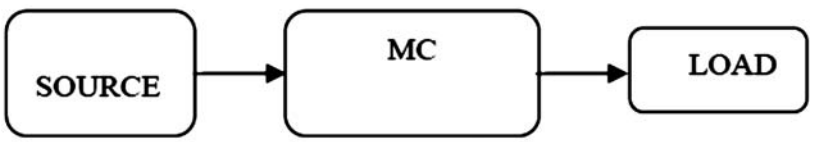

Fig. 1. Energy flow from source to load employing MC.

The 1 ϕ MC comprises of four bidirectional switches S1 to S4 as shown in Fig 2.

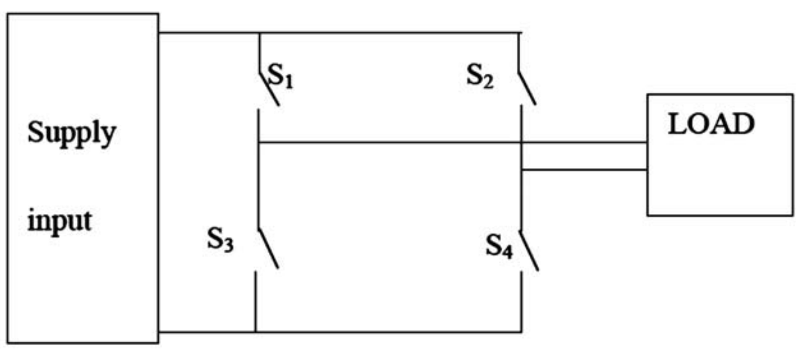

Fig. 2. Circuit configuration of 1 ϕ MC.

The power circuit for the simulation of a Matrix Converter using SPWM is shown in Fig:3

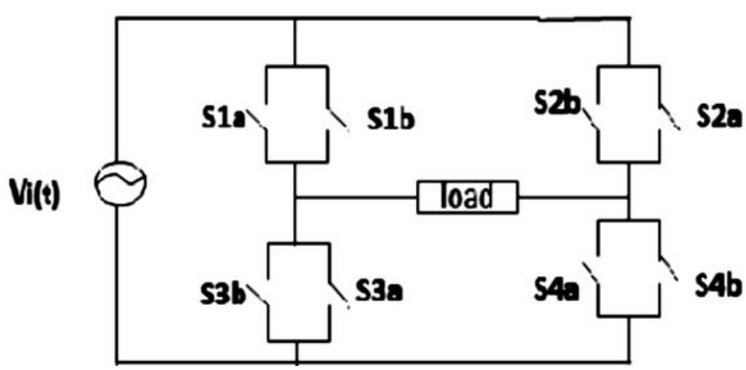

Fig. 3. Diagram for power circuit.

4. SIMULATION AND RESULTS

Fig 4 indicates the simulation diagram of 1 ϕ MC for 25 Hz frequency for induction motor without PID control. Fig 5 indicates the simulation circuit of 1 ϕ MC.

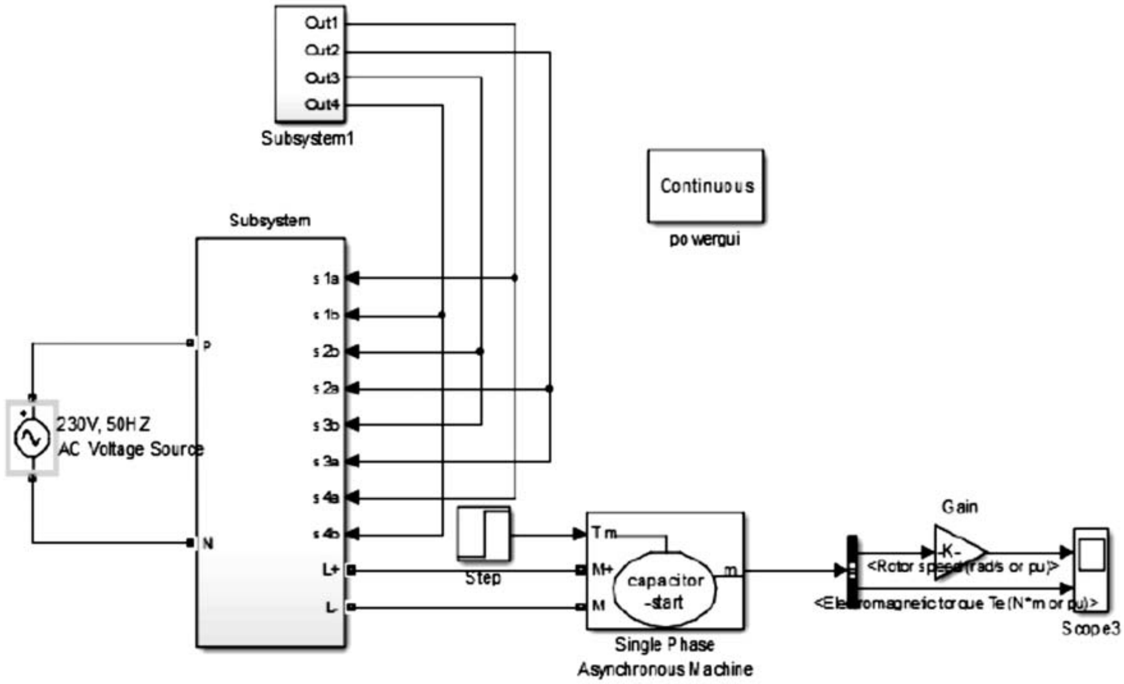

Fig. 4. ϕ MC for 25Hz employing capacitor start induction motor without PID.

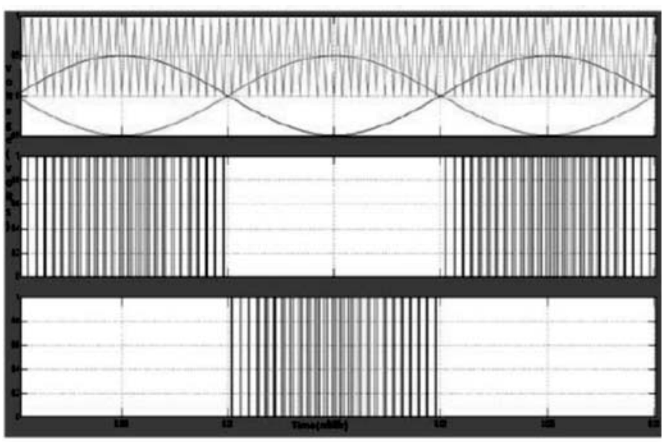

Fig. 5. Generation of pulses from SPWM.

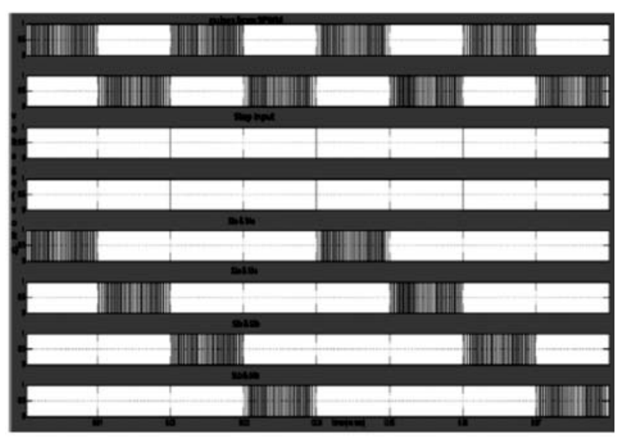

Fig. 6. Pulse sequence for 25Hz frequency.

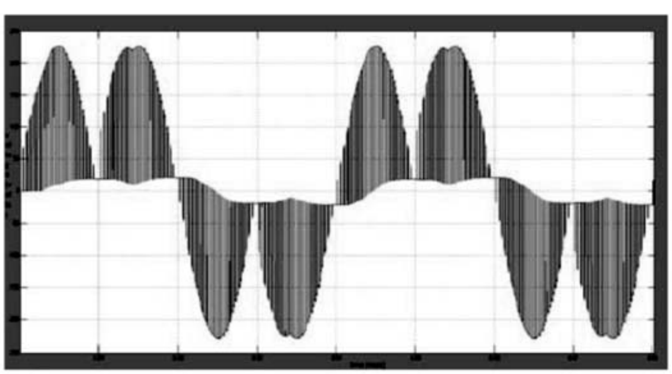

Fig. 7. Output voltage waveform for 25Hz.

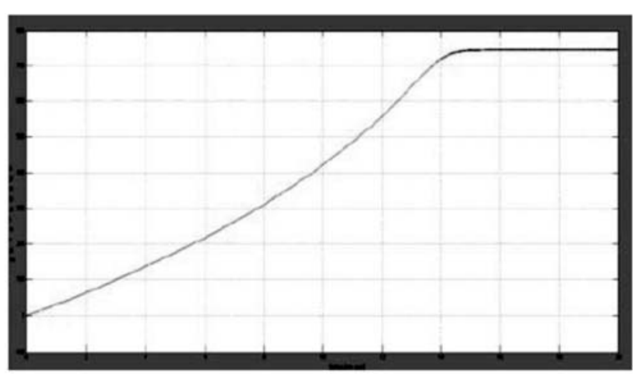

Fig. 8. Speed of IM for 25 Hz without PID.

The settling time in an open loop is 14.5m sec. it takes more time to settle. In order to reduce the settling time we are using PID controller. By this PID controller we can reduce the settling time and oscillations of the waveform.

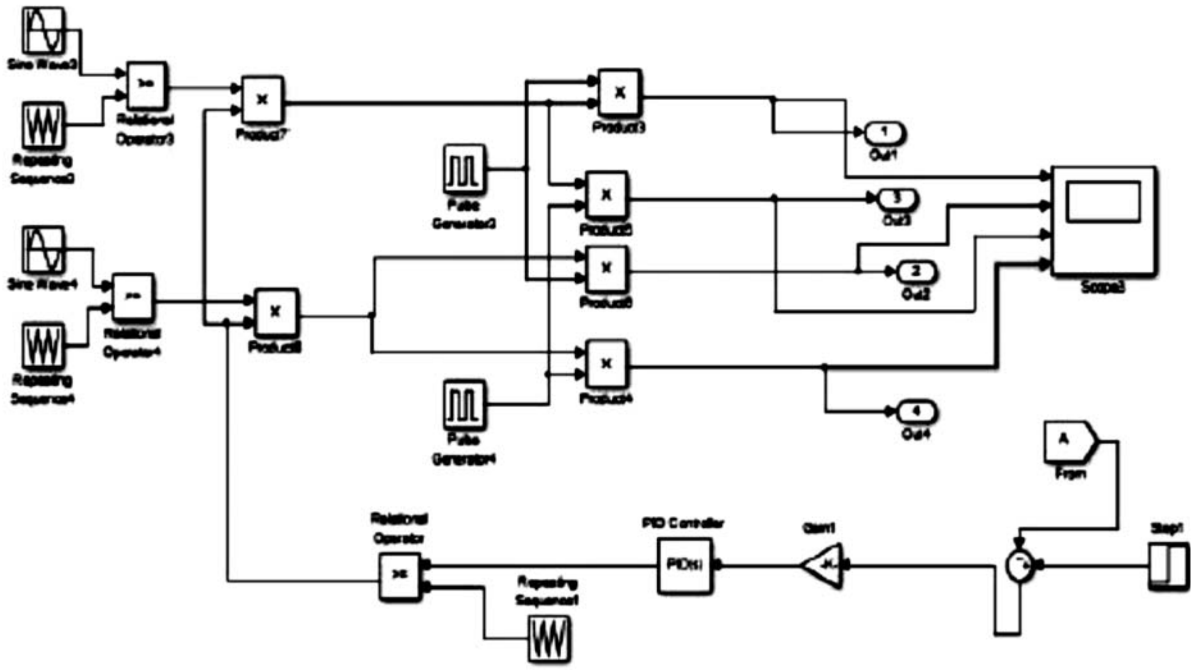

Fig. 9. SPWM with PID.

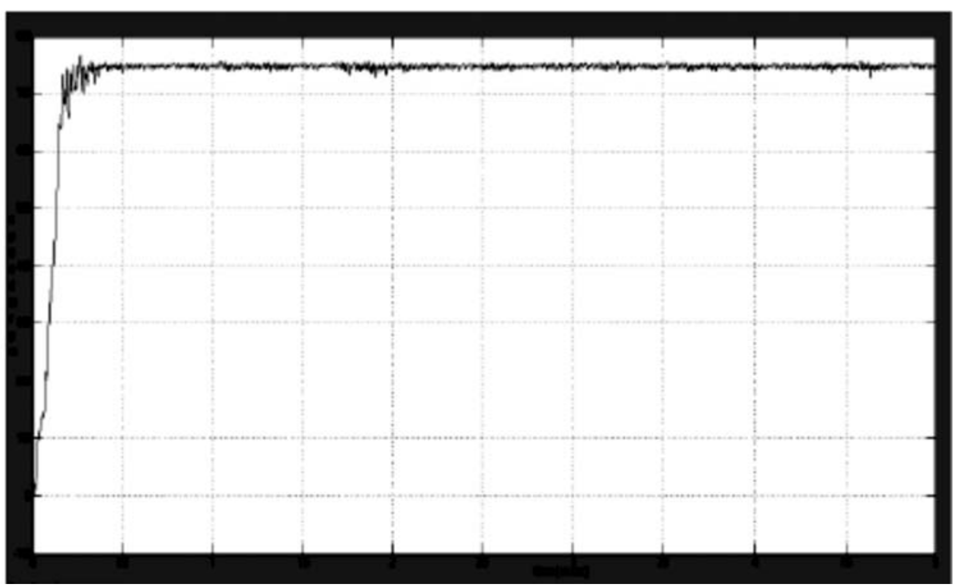

Fig. 10. Speed of the induction motor for 25Hz with PID.

5. CONCLUSION

In this paper 1 ϕ MC has been modeled and simulated. The pace of 1 ϕ induction motor has been controlled employing MC. The output voltage has been produced by applying Sinusoidal Pulse Width Modulation (SPWM) technique with IGBT as power switching devices.

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