Review of Matrix Converter Application

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Abstract
Over the last few years matrix converter gain popularity due to system become less bulky, compact in size or shape, more efficient & reduces stages of conversion process. The major influence in the research filed of electrical engineering by electric vehicle charging station in which using renewable charging station such as wind energy system VFD force control. It includes the very deep utilization in single phase or three phase matrix converter & its future in upcoming EVs charging station. This paper is a review paper of single phase & three phase of AC to AC Direct converter. Consideration about the practical implementation & constructional Bidirectional switches of matrix converter, no restriction on input & output. For single phase it will operate on 4- quadrant.

Keywords. Matrix converter, Direct Converter, MC

1. INTRODUCTION
Direct converter is successful arrangement for power conversion. It accommodates changes in force with the high effectiveness, no need of DC link capacitor for storing. At first Gyugyi proposed this technology in terms of topology in 1976. Single phase matrix converter first launch by Zuckerberger in the year of 1997 as a direct power conversion by single phase AC to AC [1, 2] with the capacity to vary the steps in that. The whole process is a single stage in direct matrix conversion that becomes the system more stable, less bulky, compact as well as high efficient.
In the future, the matrix converter use will be the need understanding of a few distinctive converter geography, now days we are utilizing. The property simple & single stage power conversion fulfill with practically everything on electric vehicle charging. Manually controlled on input as well as output side control strategy is known as sinusoidal PWM [3, 4] the converter topology is dependent on input side as of using bidirectional switches having the pair of thyristor & Diode. For medium power, circuit having IGBT OR MOSFET & for high power, circuit will have SCR. Load phase can be controlled through any input phase with the help of bidirectional switches. As full matrix converter
Could be cover completely as a varying function of AC-DC Rectifier & DC-AC inverter. With an reliable structure of the system.
The whole system may be act as revolution power electronics component uses [5, 6] for solar system in battery charging & then supply to AC load it act as rectifier & inverter

mode without dual stages Straight from matrix converter. To drive EV DC motor in both directions can possible by variation in input parameters.

2. MATRIX CONVERTER CONNECTION

The switches of bidirectional matrix converter are basically containing the switch pair of two IGBT & two diode switches. There are Total four number of switching for single stage matrix converter arrangement as shown in Figure 2.1

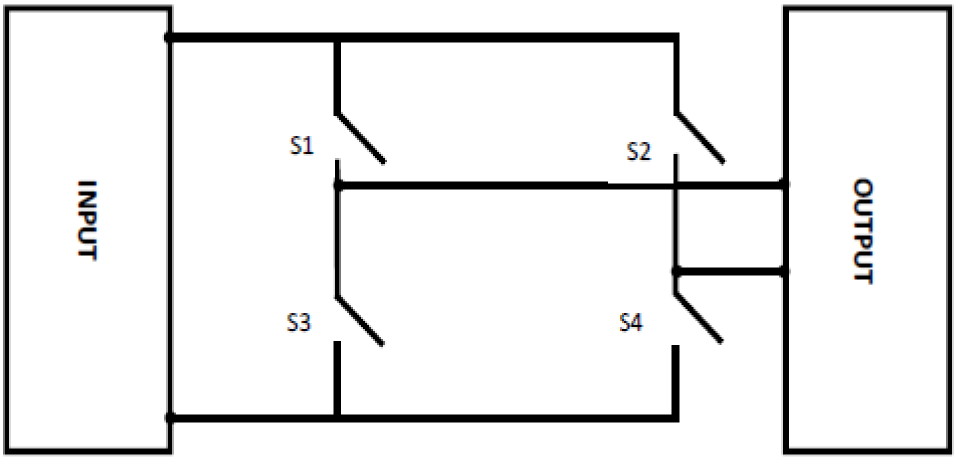

Figure 2.1 Matrix Converter Topology

The matrix converter connection is having Bidirectional switches as shown in figure and its applications depends on particular power transformation field.

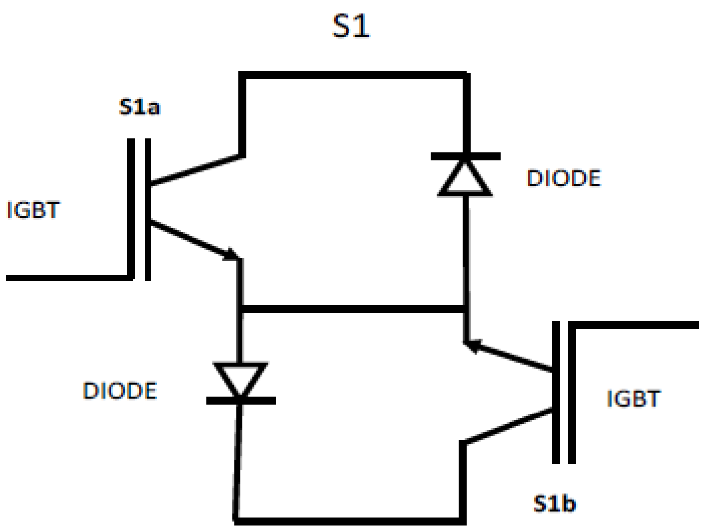

Figure 2.2 IGBT & Diode pair Bidirectional switch of Matrix Converter

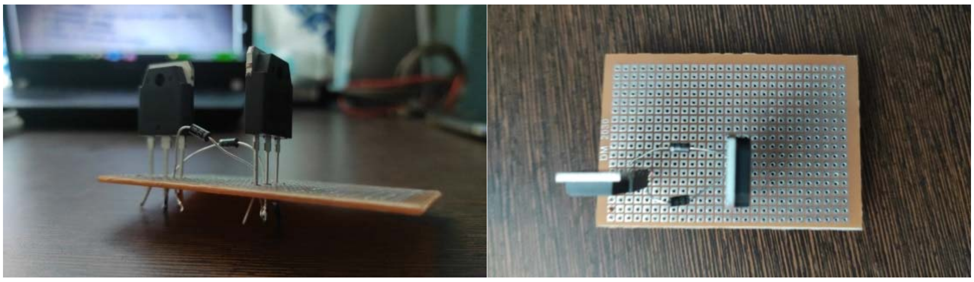

Figure 2.2 Practically Design Matrix Converter Bidirectional Switch

3. SWITCHES SEQUENCES

S. No	Input	Exchanging Arrangement	Converter Function
1	AC	1a, 4a 2b, 3b	Rectifier
2	AC	1a, 4a 2b, 3b -------------------------- 2a, 3a 1b, 4b	Dual Converter
3	DC	1a, 4a 2a, 3a	Inverter
4	AC	1a, 4a, 2b, 3b 2a, 3a, 1b, 4b	Cyclo-converter
5	AC	1a, 4a 2a, 3a 2b, 3b 1b, 4b	Cyclo-inverter

TABLE 3.1 MATRIX CONVERTER PERFORMANCES

3.1 Matrix converter as a Rectifier Mode

The Converter is functional as Rectifier for solar system by providing charging to the battery & supply to the load. In this system proper isolation is providing between AC load & battery via inverter & rectifier mode of operation. Input supply to the converter as shown in figure 2.1 for early half cycle of the input of AC, the switches 1a & 4a will be operates as mentioned details on table.

Other switch 2b & 3b will be operating for –ve cycle which is also address in MATLAB Simulink. The figure 3.2 showing MATLAB Simulink result of operate as an rectifier with AC input supply of 230 V. the review is done for resistive limit.

3.2 Matrix Converter as a Dual Converter

The converter is ac as a dual converter. The converter is shown in figure 3.5. It having the bidirectional switches. For early +ve cycle, the switches 1a & 4a will be operate & for –ve cycle 2b, 3b will be operate as mentioned on table. The MATLAB Simulink result address in the figure 3.6.

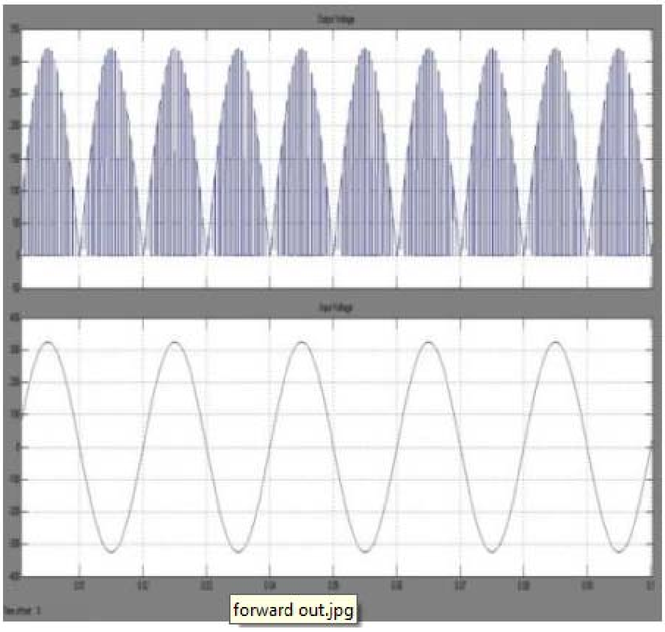

Figure 3.1 Rectifier mode of Matrix direct converter as Input voltage vs Output voltage

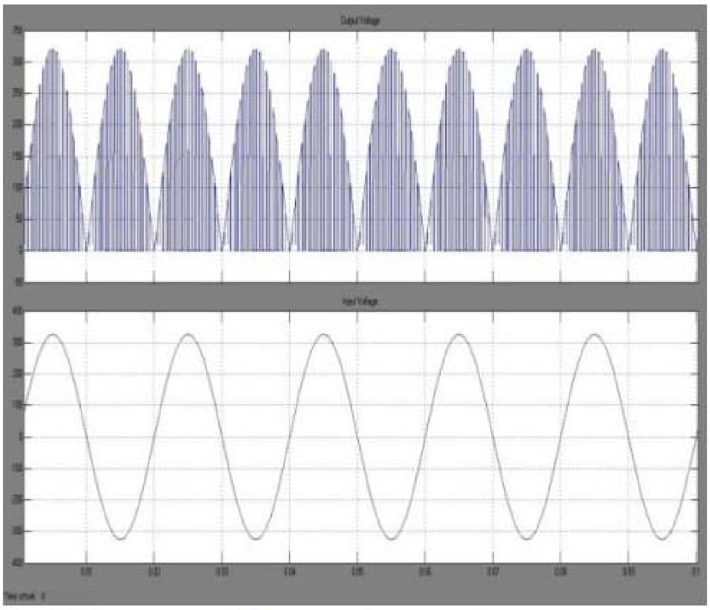

Figure 3.2 Positive DC output voltage vs input voltage

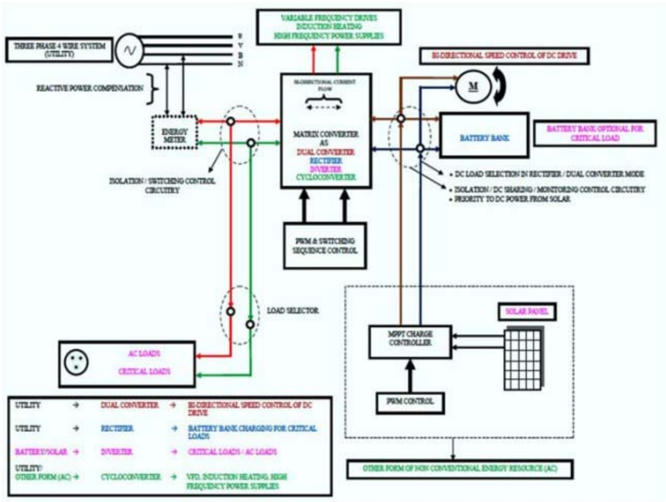

Figure 3.3 Birds' Eye view of Matrix Converter applications

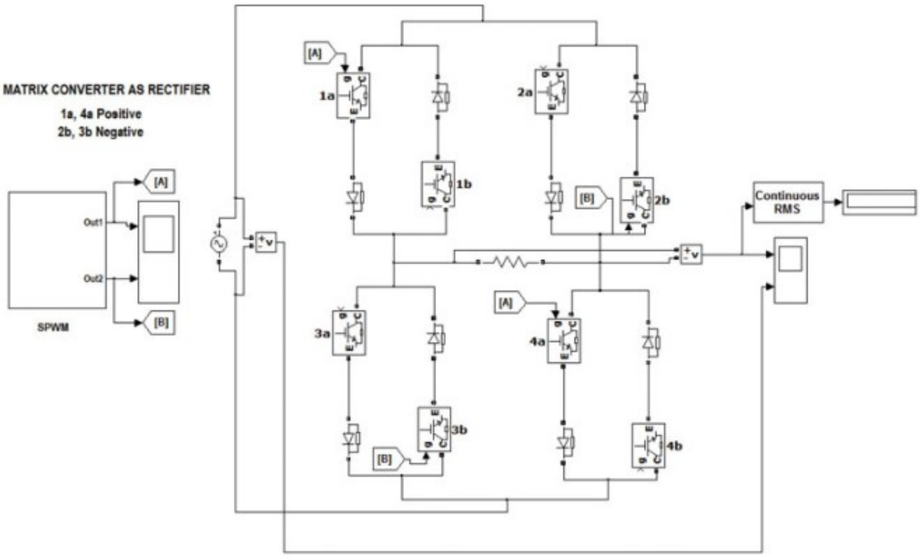

Figure 3.4 Circuit of Matrix Converter Simulation as Rectifier

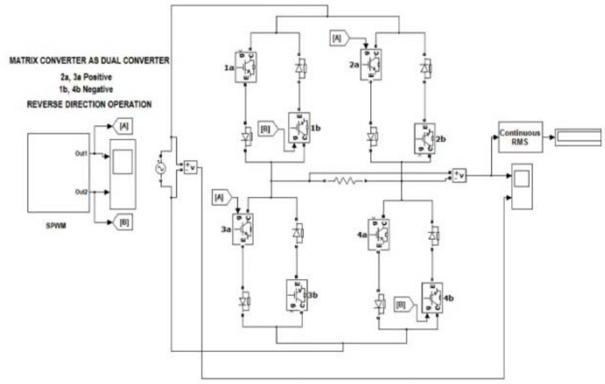

Figure 3.5 Circuit of Matrix Converter Simulation operating as dual converter

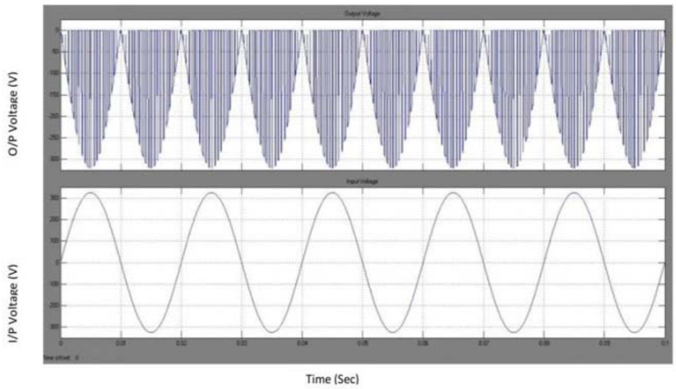

Figure 3.6 Negative DC output voltage vs input voltage

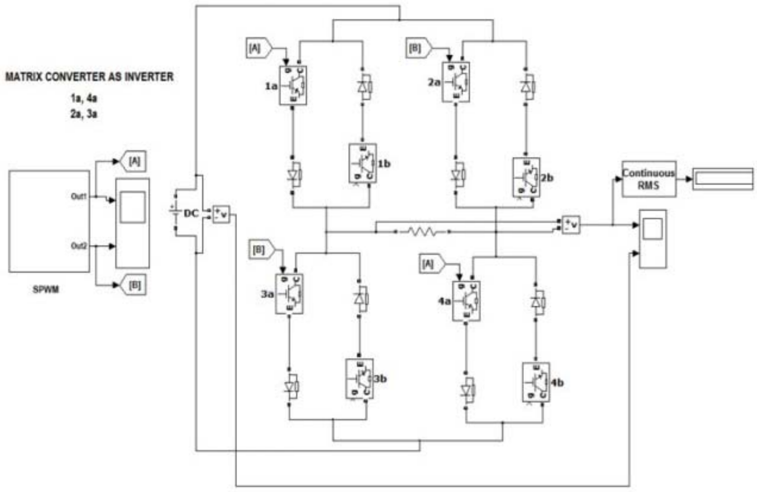

Figure 3.7 Simulation circuit of Matrix Converter as Inverter

3.3 Matrix Converter as Inverter

The Matrix Converter as inverter keep possibly be made to drive AC motor with its flexible frequency inverted AC output as speed control of AC drive via changing the frequency. If input to the matrix converter is DC & switching sequence details mentioned in table 1a, 4a, 2b & 3b will operate inverter as giving Alternating output of the frequency of PWM frequency. The MATLAB Simulink result is mentioned in the Figure 3.7 and Figure 3.8.

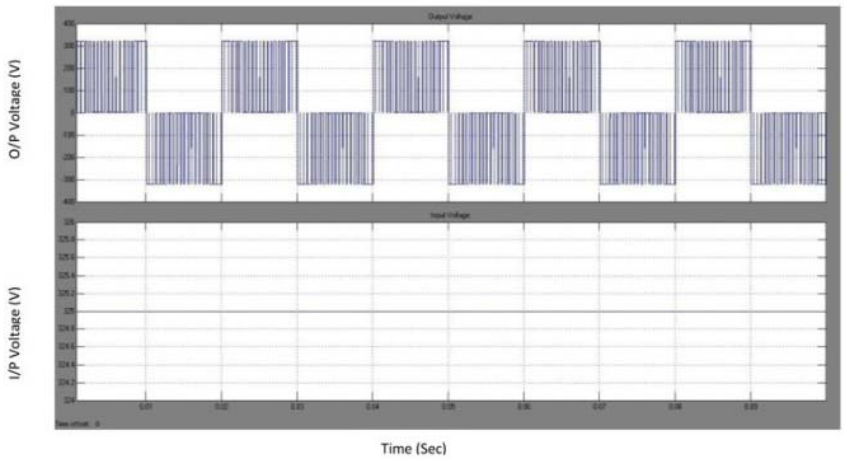

Figure 3.8 Simulation output of Inverter operation by Matrix Converter

The inverter operation of Matrix Converter could be applied to produce the AC voltage output of the required frequency by varying the frequency of the pulse width modulation. This operation could implement for controlling the speed of AC drive via variation in frequency. The input DC to the converter with that of the reference cycles. This operation could be implemented for controlling the speed of AC drove via variation in frequency. The storage system is use for emergency operation for load, therefore by solar system AC supply can be received by DC input.

3.4 Matrix Converter as Cyclo-converter

As mentioned in details table, the switching operation will be for +ve half cycle is 1a, 4a, 2b & 3b. for –ve half cycle it will be 2a, 3a, 1b & 4b. the MATLAB Simulink result is mention in figure 3.10 and MATLAB designing circuit as shown in figure 3.9.

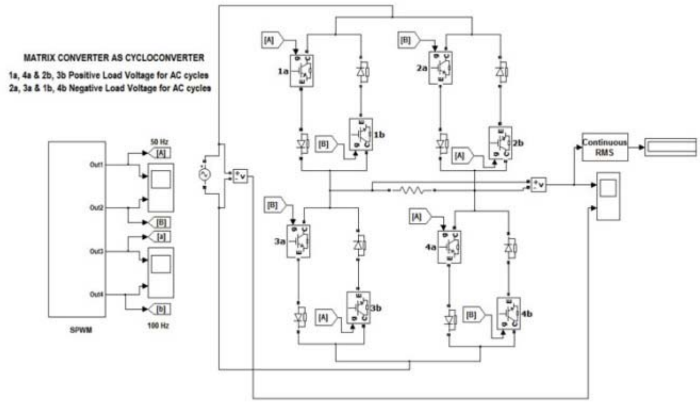

Figure 3.9 Simulation circuit of Matrix Converter as Cyclo-converter

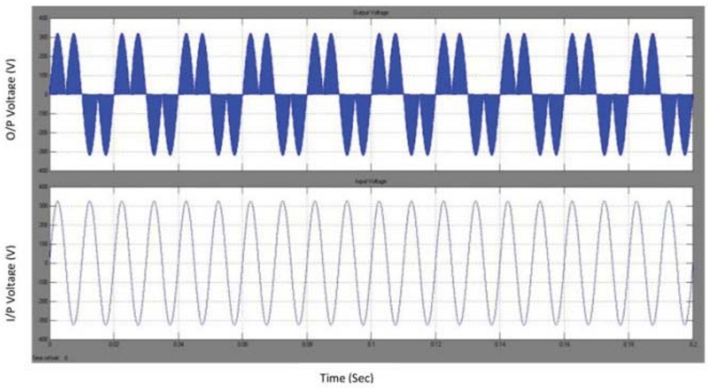

Figure 3.10 Simulation output of Cyclo-converter (100Hz input vs 50Hz output)

Here, the output frequency is given by, fo = fin/Nr, 50=100/2, in which the desired output is accomplish by the SPWM pulses of the reference frequency of 50Hz. Figure.12 shows the AC output voltage of 50Hz for the 100Hz AC input waveform.

3.5 Matrix Converter as a Cyclo-inverter

As a switching mentioned in table, the switching will be operate for +ve half cycle is 1a, 4a, 2a & 3a. for –ve half cycle it will be 2b, 3b, ib & 4b. the MATLAB Simulink result is mentioned in figure 3.12 by designing circuit as shown in figure 3.11

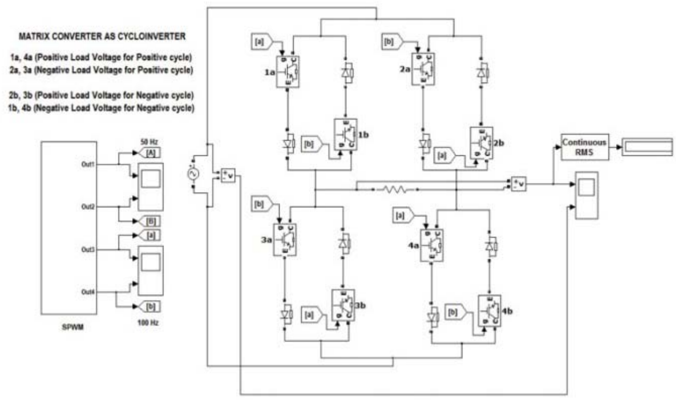

Figure 3.11 Simulation circuit of Matrix Converter as Cyclo-inverter

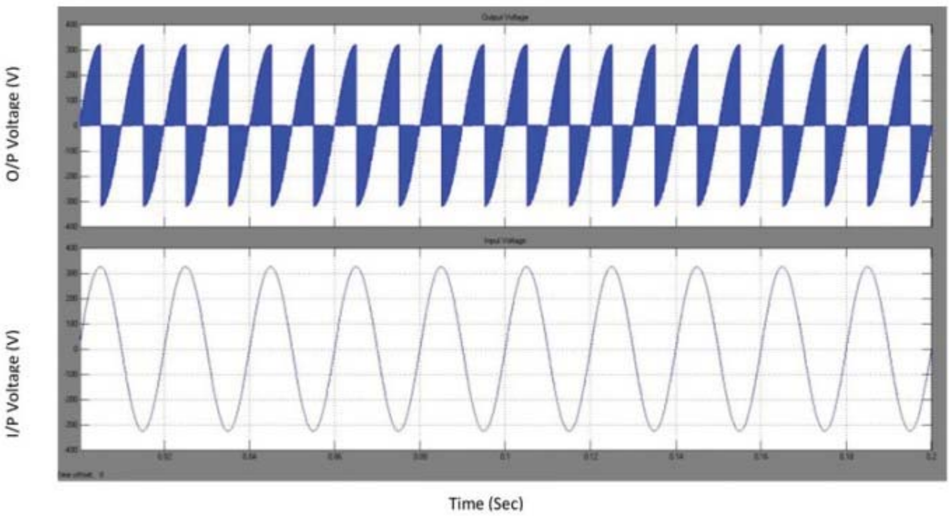

Figure 3.12 Simulation output of Cyclo-inverter (100 Hz vs 50 Hz)

4. MODULATION TECHNIQUES

A. Sinusoidal Pulse Width Modulation (SPWM) PWM is a recent technique, made practical by modern electronic power switches.The main benefit of carrier based SPWM is that the complication is very low and the dynamic response is also good for Matrix Converters [11].

5. THE FAMILY OF MULTI LEVEL MATRIX CONVERTER

Matrix conversion is having the ability of direct power conversion. Also increasing the efficiency as well as magnitude of the circuit by using extra level topology as per detailed table 5.1 is mentioned.

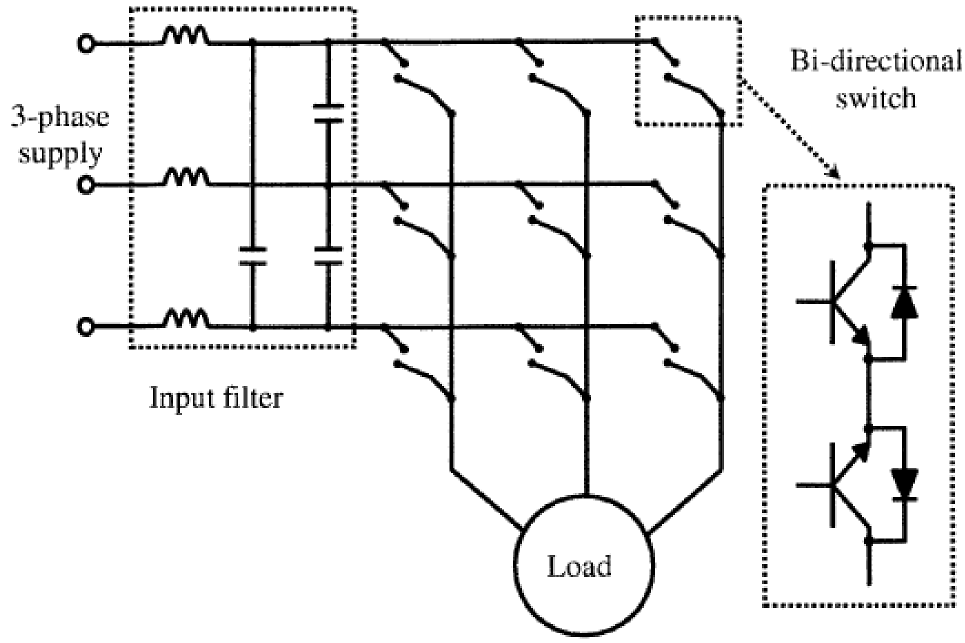

Figure 5.1 AC-AC Matrix Converter

Family of Multi-level Matrix Converter Topologies

Matrix Converter Topology	Multi-Level Converter Topology	Resulting Multi-Level Matrix Converter Topology
Two Stage Matrix Converter	Diode Clamped Multi-Level Converter	Two Stage, Three Level Matrix Converter
Standard Matrix Converter	Capacitor Clamped Multi-Level Converter	Flying Capacitor Multi Level Matrix Converter
Standard Matrix Converter	H-Bridge Multi Level Converter	H-Bridge Multi Level Converter

Table 5.1 the Family of Multi-level Matrix Converter Topologies

6. THREE LEVEL MATRIX CONVERTER BY TWO STAGES

In direct matrix conversion by two stage as shown in figure 6.1 to connection of diode & output step is given to the three level inverter by midpoint through the neutral for providing extra voltages.

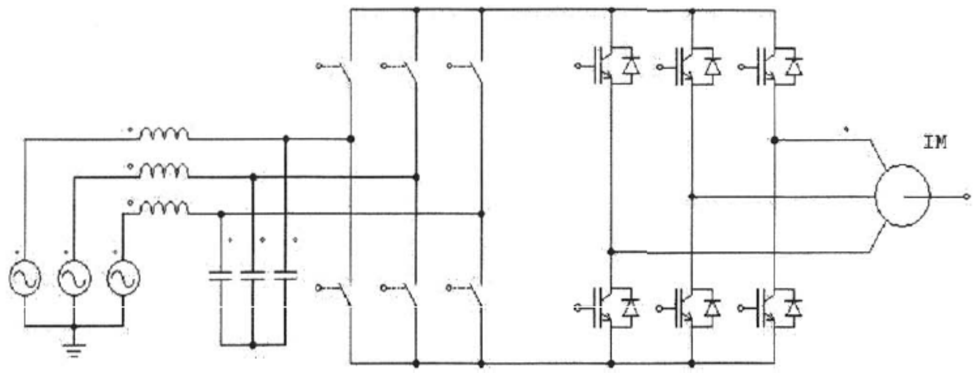

Figure 6.1 Three level Matrix Conversion by Two Stages

In order to modulate the converter a combination of space vector modulation techniques for Matrix Converters and Multi-level converters has been established.

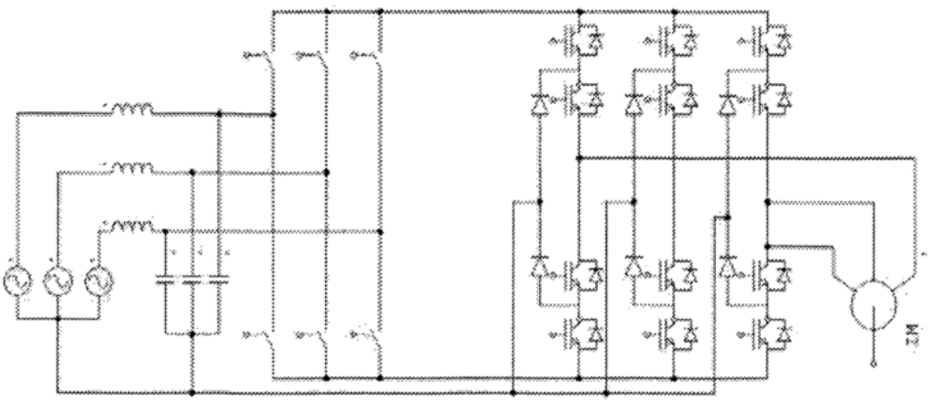

Figure 6.2 the Three-level-output-stage Sparse Matrix Converter

7. CONCLUSION

The review of SPMC and analysis then it is proportional system for direct conversion as well as indirect conversion for particular application which reduces the system become bulky, losses are less etc. the output load can be controlled by varying any input phase which is link to many bidirectional switches. In three phase matrix converter it is having nine number bidirectional switches, with that any load supply can be controlled through any input phase & also having the possibility to control the load frequency by different switching operation as well as in SPMC.

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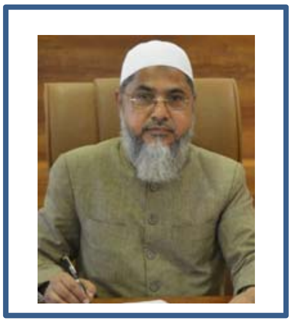

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