Simulation of Three-Phase Matrix Converter

Mr. Aqhil Ahmed Mohamad1 Prof. Sanjay Gothwal2 Prof. Sanjay Jain3
1Research Scholar
2,3SSS College of Engineering, RKDF University, Bhopal, Madhya Pradesh, India

Abstract—This paper aims to give a general description of the basic features of a three phase to three phase matrix converter in terms of performance and of technological issues. This paper does not require to the reader a special knowledge of the matrix converter technology. It is worth noting that the three phase to three phase configuration is just one of the possible direct AC-AC converter topologies [1], which are not in the scope of the present report.

Keywords: Matrix converters, AC-AC converter topologies

I. INTRODUCTION

Matrix converter is an AC to AC converter that converts fixed ac voltage into a variable voltage and variable frequency supply without employing a bulky energy storing device such as capacitor. Due to this advantage, matrix converter is replacing conventional AC-DC-AC converters. The main advantage of a matrix converter is that it can convert the input three phase supply into a variable voltage variable frequency supply. Its input and output waveforms are purely sinusoidal, and does not contain higher Order harmonics. Furthermore, sub harmonics are absent in the output. This variable supply can be used to drive an induction motor and permanent magnet synchronous motors. Other advantages include absence of DC link capacitor and reduced no of switches. Therefore, size of the converter also minimizes. On the other hand, as other circuits matrix converter too has some disadvantages. It can transfer maximum of 87% of input voltage to the output side. No of semiconductor devices are more as compared to ordinary converters. Lastly, it is very sensitive to the fluctuations. Such converter comes with 9 units of bi-directional switches. With the help of these switches, any of the output phase can be connected to any of the input phase resulting in variable voltage variable frequency output. Total of 512 switching combinations can be employed on a single three phase matrix converter. Even though most of these combinations are not useful. The usefulness of the switching combination depends on 2 things. Current should never be interrupted. Based upon these rules, it can be concluded that only one output phase should be connected to the input.

II. TOPOLOGY

The matrix converter consists of 9 bi-directional switches that allow any output phase to be connected to any input phase. The circuit scheme is shown in Fig.2.1. The input terminals of the converter are connected to a three phase voltage-fed system, usually the grid, while the output terminal are connected to a three phase current- fed system, like an induction motor might be. The capacitive filter on the voltage- fed side and the inductive filter on the current- fed side represented in the scheme of Fig.2.1 are intrinsically necessary. Their size is inversely proportional to the matrix converter switching frequency [2] It is worth noting that due to its inherent bi-directionality and symmetry a dual connection might be also feasible for the matrix converter: a current- fed system at the input and a voltage- fed system at the output. With nine bi-directional switches the matrix converter can theoretically assume 512 (29) different switching states combinations. But not all of them can be usefully employed. Regardless to the control method used, the choice of the matrix converter switching states combinations (from now on simply matrix converter configurations) to be used must comply with two basic rules. Taking into account that the converter is supplied by a voltage source and usually feeds an inductive load, the input phases should never be short-circuited and the output currents should not be interrupted. From a practical point of view these rules imply that one and only one bi-directional switch per output phase must be switched on at any instant. By this constraint, in a three phase to three phase matrix converter 27 are the permitted switching combinations.

III. SPACE VECTOR MODULATION FOR INVERTER

In this section, the introduction of SVM in the Inverter and Rectifier stage is presented. The final output voltages are represented by multiplying inverter transfer function I to virtual DC-link voltage VDC. On the same time, IDC which is the DC link current has been represented by IT.
To know the values of the output voltage and output voltage angle, there are 6 switches in inverter stage that is represented in order S7, S8, S9, S10, S11, and S12 and when a switch is off by it is denoted by ‘0’ and when a switch is on it is denoted by “1”. Consider that inverter stage of the active vector V1 [1 0 0]. In this active stage, switch number 7 has been switched on from the upper part and switch number 10 and 12 from the lower part shown in Figure.3.

**Fig. 3:** Inverter Stage when switches S7, S10, S12 are on in the Equivalent model of the Inverter Stage

### IV. SPACE VECTOR MODULATION FOR RECTIFIER STAGE

This section introduces SVM for the Rectifier stage. In the previous section, the analysis has been done for the inverter stage. The equivalent circuit is shown in Figure.4.

**Fig. 4:** Rectifier stage from the equivalent model

$$\begin{bmatrix} I_a \\ I_b \\ I_c \end{bmatrix} = \begin{bmatrix} S_3 & S_2 \\ S_5 & S_4 \\ S_6 & S_5 \end{bmatrix} \begin{bmatrix} I_{pc,+} \\ I_{pc,-} \end{bmatrix}$$

$$\begin{bmatrix} V_{pc,+} \\ V_{pc,-} \end{bmatrix} = \begin{bmatrix} S_1 & S_3 & S_5 \\ S_2 & S_4 & S_6 \end{bmatrix}$$

To know the values of the Input Current and Input Current phase angle. In Rectifier we have two output DC values. Consider that inverter stage of the active vector V1 [1 0 0]. In this active stage, switch 1 has been switched on from the upper part and switch 4 from the lower part shown in Figure .5.

**Fig. 5:** Equivalent circuits for Rectifier Stage when Switches S1 and S4 are closed

There are 6 switches in rectifier stage and the respective vectors are presented in Table.4. Tables are presented in section 5 as appendix. Error! Reference source not found. time interval of the Vectors active I3, I4 and Zero vector I0c and V7 having a time interval of T3, T4 and T0c respectively. Error! Reference source not found.. This explains the switching states of all the switches S1 to S6 in all six sectors of the Rectifier stage.

### V. SIMULATION AND RESULTS

The system consists of a three-phase matrix converter (MC) constructed from 9 back-to-back IGBT switches. The MC is supplied by an ideal 50Hz three-phase source and drives a static resistive load at 50Hz. The switching algorithm is based on an indirect space-vector modulation described in [1] which considers the MC as a rectifier and inverter connected via a DC link with no energy storage. Indirect space-vector modulation allows direct control of input current and output voltage and hence allows the power factor of the source to be controlled. The switching algorithm utilizes a symmetric switching sequence described in [2].
VI. CONCLUSION
The switched-inductor and quasi-Z-source circuits, embedded in the ultra-sparse matrix converter topology, allow interfacing a low-voltage generator with the grid in wind energy systems. The efficiency of the proposed converters is expected to be high due to reduced number of power electronic switches. Furthermore, the shoot-through state is no longer a hazard, which improves the reliability of the proposed converters. The THD analysis of input and output currents has shown slight superiority of the SIZMC over the QZMC with respect to the quality of input currents. It should be noted that the SIZMC and QZMC do not allow bidirectional power flows. Thus, the generator cannot be used for starting the turbine. The bidirectional power flow would require adding three more switches to the rectifier part, converting the ultra-sparse matrix input stage to a sparse-matrix one.

REFERENCE

