Single-Stage AC-AC Modified Converter

K S Srikanth

Department of Electrical and Electronics Engineering, KHNR College of Engineering, Guntur
Corresponding Author: srikantheee@gmail.com

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Abstract: *The description of the single stage AC-AC converter is provided in the paper. If you can't get a proper quasi-direct back-to-back converter, this will work instead. This type of converter is called Matrix Converter. A matrix converter which consists of controlled by semiconductor switches, is used to connect a three-phase load to a three-phase source. Sinusoidal input and output waveforms, possible power flow from either direction and no dc link storage parts are features of this converter. The simulation model and its results demonstrate how the Venturini control approach is implemented in matrix converters.*

Keywords: *Storage components, Venturini control mechanism, Matrix converter, Back-to-back converter, Bidirectional power flow*

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I. Introduction

Handling and changing energy is a major process in electrical engineering. In the last few years, capacitors, inductances and power semiconductors have played a role in my work. A variety of converter families, including rectifiers, cycloconverters, choppers and inverters, have been designed. All of these families have both positive and negative features. Efficiency stands out as the major benefit when comparing static converters with other energy processors.

The matrix converters (MCs) are especially interesting as a type of converter. The AC-AC matrix converter design may take over the roles of conventional AC-AC converters which were both costly and bulky. The design of this converter will contribute to developing industrial AC drives and producing power from wind energy. This configuration is applied in several domains, including generating wind energy, driving industrial alternating current motors, boat applications and military equipment for vehicles and aerospace.

II. Literature Review

In 1974, the first work on direct AC/AC frequency converters appeared, published by [3]. Most of the time, DC-AC conversion of power frequency is the process of altering the frequency of AC power. Apart from holding the output frequency to match the power frequency converter and input frequency also controls the output voltage's amplitude. They are designed to work with both output and input power. Static power frequency converters are classified into two types. An indirect DC-AC converter power frequency is the initial type, featuring a second-stage power converter with an intermediary DC link. The second criteria is identified as a direct DC/AC converter power frequency.
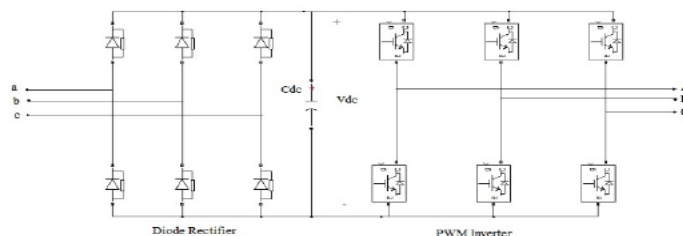

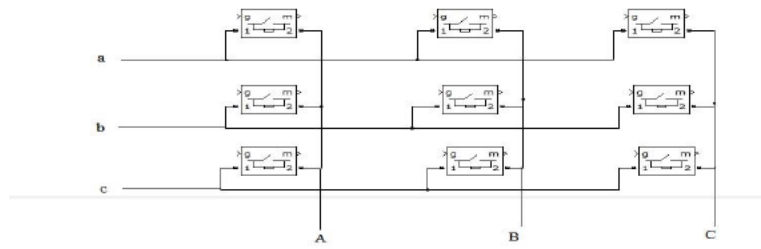Fig 1: Diode rectifier-PWM VSI converter

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Fig 2: Direct AC/AC converter

III. Matrix Converter

Researchers have spent the past 20 years examining matrix converters. Researchers started to examine an AC/DC/AC matrix converter as an advanced and efficient approach for converting electricity for uses such as AC motor drives, variable frequency generators, uninterruptible power supplies, and reactive energy controls. Still, the use of power converters in industry is limited by the problems of bidirectional switch realization, using PWM, synchronization and protection [3]. Here, the mathematical models and tools were explained that are utilized to analyze the usual control approaches used with matrix converters.
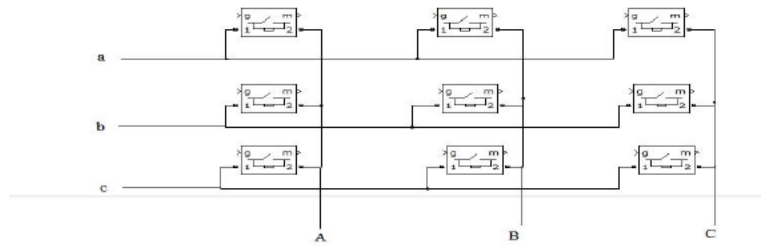

Fig 3: Basic Power Circuit of the Matrix Converter

IV. Utilization of Venturi

Matrix converter control was first developed by Alesina [1] and Venturini [3]. The AC-AC matrix converter can adjust its signal to generate sinusoidal input and output waves. Choosing the right modulation strategy helps keep the device's energy use low and keeps harmonic distortion in the voltage and current down. The first modulator for matrix converters was built upon a scalar model known as Venturini modulation [2]. The system can transfer a maximum voltage ratio of 0.5. The concluding chapter gives a mathematical explanation of the Matrix Converter using simple Boolean functions.

Being versatile, the wiring points of the Matrix Converter can appear in any order. For regular operation, we should think of one holding port as voltage stiff and the other as current stiff. Voltage or current should never experience sudden, major changes when working under stiff conditions. For this analysis, we treat the input port as voltage stiff and the output port as current stiff. An input filter in a practical matrix converter allows it to produce the smooth voltage indicated in figure 4 by blocking high switching harmonics.
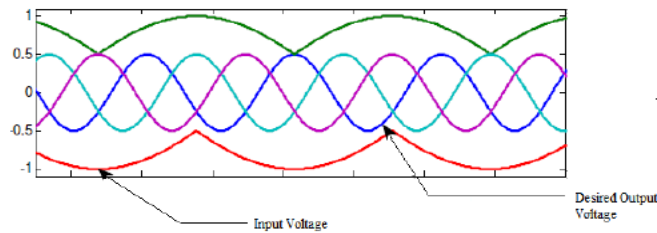
Fig 4: Output voltages, Vo = 0.7 Vi

V. Simulation Model

The simulation model shows the complete workings of the Basic Venturini Control Method. The fundamental idea of the matrix converter was demonstrated by creating and simulating this model in MATLAB-Simulink software. Using the tool, you get the values for M and t that represent the system. See Figure 5 for the general design of the module that forms components matrix M(t). This module works on the given output voltages Vi and MC voltages either VI or VR.
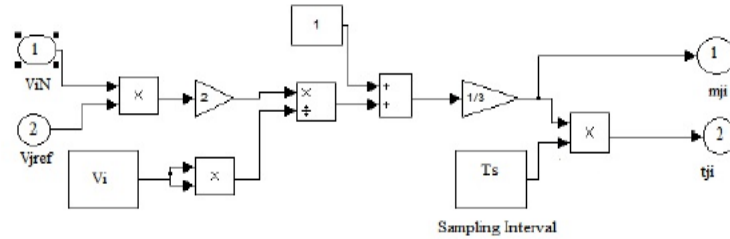

Fig 5: Generation of duty cycle mji in Matlab –Simulink software package
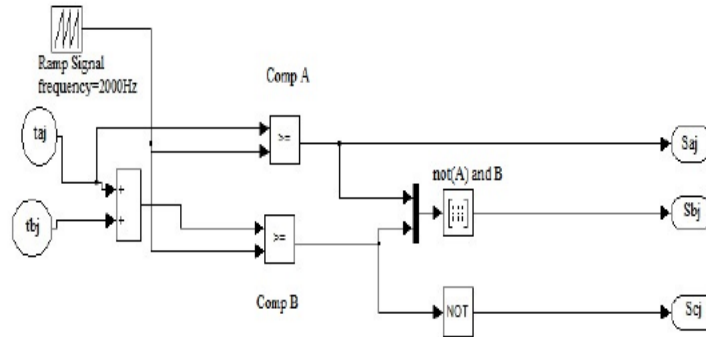
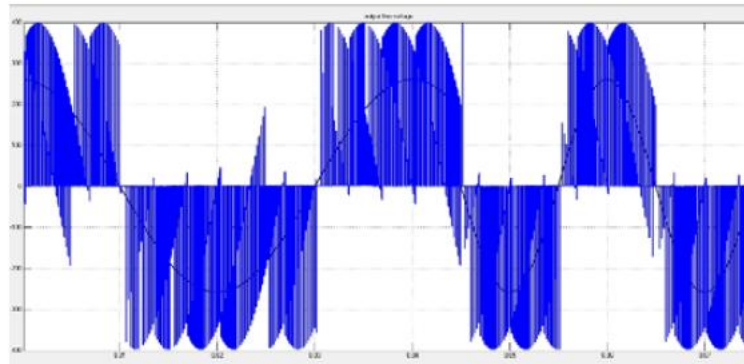

Fig 6: Pulse generation scheme for one output phase

Fig 7: Output frequency changes as the reference frequency changes

VI. Conclusion

In this study, methods for Venturini modulation in three-phase-to-three-phase matrix converters are introduced. For calculating both the duty ratio for each switch and the resulting sinusoidal input current and output voltage, we will set the desired output voltage and build a modulation matrix from that number. A simulation in MATLAB confirmed that the method was sound and effective. From this, it seems that this method serves as a matrix converter able to transform ac to ac.

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