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Generalized theoretical functional model for Three-Phase Matrix Converters

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Abstract – In this paper it is presented a theoretical functional model for three phase matrix converters. These analyses methods are based on converter function rather than power switches circuit configuration. Such a method complements the detailed mode analyses and enhances the efficiency of the computer aided analysis and design of power matrix converters.
Keywords: power electronics, matrix converters

I. INTRODUCTION

The general analyses of power matrix converters have been mainly based on their respective circuit topologies and associated switching patterns. However, in the general theory of switching power converters it is demonstrated that analyses according to function permits better understanding of converter behavior [1]. Thus the transfer function concept is a powerful tool in understanding and optimizing converter performance. The transfer function is widely used for linear systems. The idea of describing the input output behavior of matrix converters allows the designer to easy develop the necessary switching functions. The model based on transfer functions increases the speed of simulation, and the computer aided analyses and design of matrix converters.

II. THE FUNCTIONAL MODEL FOR THREE-PHASE MATRIX CONVERTERS

The symbolic model of the ideal three-phase matrix converter is shown in Fig.1. The output voltages are synthesized by means of the input voltages and the

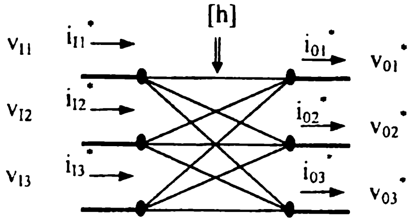

Fig. 1. Symbolic model of the three-phase matrix converter

connexions between inputs and outputs. The relationship between outputs and inputs is

$$\begin{bmatrix} v_{O1}^{\bullet} \\ v_{O2}^{\bullet} \\ v_{O3}^{\bullet} \end{bmatrix} = \begin{bmatrix} h_{11} & h_{12} & h_{13} \\ h_{21} & h_{22} & h_{23} \\ h_{31} & h_{32} & h_{33} \end{bmatrix} \cdot \begin{bmatrix} v_{I1} \\ v_{I2} \\ v_{I3} \end{bmatrix} \tag{1}$$

or

$$[v_O^{\bullet}] = [h_{FF}]\,[v_I] \tag{2}$$

where

$$\left[v_O^{\bullet}\right] = \begin{bmatrix} v_{O1}^{\bullet} \\ v_{O2}^{\bullet} \\ v_{O3}^{\bullet} \end{bmatrix} = \sqrt{2}V_O \begin{bmatrix} cos(\omega_O t) \\ cos\left(\omega_O t - \frac{2\pi}{3}\right) \\ cos\left(\omega_O t - \frac{4\pi}{3}\right) \end{bmatrix} \tag{3}$$

is the wanted output voltages matrix,

$$[v_I] = \begin{bmatrix} v_{I1} \\ v_{I2} \\ v_{I3} \end{bmatrix} = \sqrt{2}V_I \begin{bmatrix} cos(\omega_I t) \\ cos\left(\omega_I t - \frac{2\pi}{3}\right) \\ cos\left(\omega_I t - \frac{4\pi}{3}\right) \end{bmatrix} \tag{4}$$

is the input voltages matrix and

$$[h_{FF}] = \begin{bmatrix} h_{11} & h_{12} & h_{13} \\ h_{21} & h_{22} & h_{23} \\ h_{31} & h_{32} & h_{33} \end{bmatrix} \tag{5}$$

is the phase to phase with the same neutral point, like in Fig.2, transfer functions matrix. The relationship between output and input currents is

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