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# Performance Analysis of a Three-to-Five Phase Dual Matrix Converter Based on Space Vector Pulse Width Modulation

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**ABSTRACT** In this paper, space vector pulse width modulation (SVPWM)-based algorithms for a five-phase open-end load fed from dual matrix converter (DMC) have been proposed. In the presented modulation methods, the reference output voltage vector is synthesized from two three-to-five phase matrix converters at both the ends of the load. Depending on the power-sharing of the two MCs, two proposed modulation methods are defined as equal reference sharing (ERS) and unequal reference sharing (URS). The performance of ERS and URS for the three-to-five phase DMC drive is compared. Performance comparison is based on the total harmonic distortion in the output voltages and the percentage of the voltage transferred from the source to the load, for the full linear modulation index (MI) range. Common mode voltage and zero sequence current in the load are also discussed. The efficiency of the ERS and URS is compared. It has been observed that the proposed ERS scheme offers better performance compared with URS for most of the MI values. The suggested modulation techniques are implemented in MATLAB/Simulink. The hardware setup is developed and control algorithm is implemented using dSPACE working in conjunction with the FPGA interface board for practical validation.

**INDEX TERMS** Dual matrix converter, modulation index, multiphase, open-end load, space vector pulse width modulation.

## I. INTRODUCTION

The multiphase drive system is a viable alternative for high power industrial applications. Multiphase drive systems are accompanied with; improved fault tolerance, reduced torque pulsation, and reduced power converter switch rating. All AC machines require only two current components (namely *d-q*) for independent torque and flux control. An n-phase machine can continue to operate due to the presence of a rotating field in the post-fault operation as long as no more than (n-3) phases are faulted. Most power supply schemes, discussed in conjunction with both three-phase and multiphase machine drive systems, are of a so-called single-sided supply type. This means that the machine has an isolated neutral point and power converter feeds it from the available terminals. However, it is also possible to realize the machine supply system using different schemes. For example, the stator windings are fully opened from both the ends and two converters (rather than one) can be used to supply it from both sides. This structure is known as open-end winding (OEW) machine fed from the dual converter. It has been under extensive investigation [1]–[3]. The OEW machine drive system offers numerous advantages over a conventional single-sided drive system. Some of them are: i) each of the converters is rated to one half of the total power, if both of them share the power equally, ii) there is a possibility for CMV reduction (for isolated dual supply system only) iii) fault tolerance is improved due to power converter supply redundancy [4], [5]., iv) multilevel output is achieved and the number of levels in the output voltage can be varied by changing the DC link voltage ratio (if inverters are used). Though, OEW drive can have some shortcomings, such as [6], [7]: zero sequence current might flow in the winding of the machine due to the zero sequence voltage. Moreover, a complex power converter is required which has more circuit gate drives and more power electronics devices, etc. A comparative study of the open-end topology has been done with equivalent

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