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ORIGINAL RESEARCH

Experimental analysis of advanced control technique for a five-phase direct matrix converter based on space vector PWM

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Abstract

The multiphase matrix converter outperforms the conventional three-phase system with higher fault tolerance capability and higher power control competency. This paper discusses the direct control based on different possible switching combinations of a three-phase to five-phase matrix converter (MC). The proposed control topology significantly reduces the switching commutations in a switching cycle when compared with its counterpart. The control is based on the modified space vector pulse width modulation (SVPWM) strategy. The proposed space vector scheme intelligently selects the voltage vectors to get the desired output characteristics with the least possible switching transitions in a switching cycle. Three possible cases exist in controlling space vectors based on their magnitude, the number of active switching vectors, and their commutations. The results for three different cases of SVPWM have been presented and compared. The total harmonic distortion (THD) obtained in the output is lower in case 2; however, it suffers from a higher common-mode voltage (CMV). The scheme has been successfully implemented and verified in hardware.

1 | INTRODUCTION

Multiphase systems have higher fault tolerance and, consequently, higher reliability than three-phase counterparts. This feature makes it a good choice for sensitive application areas such as traction, aerospace engineering, and hybrid electric vehicles. Apart from the highly reliable operation, it has the added benefit of reduced pulsation in torque, lesser acoustic noise, and the lowering of various losses. The rating of the device is also reduced for the multiphase system. Various works have shown that a multiphase drive system with a stator having a higher phase number enables smooth and independent vector control operation for speed control [1–4]. Recently, an existing three-phase synchronous reluctance machine performance is compared with an identical machine that is upgraded to a five-phase machine. The performance parameters were torque ripple and torque in fault and healthy conditions. The results verified that the five-phase had 11.8% higher torque, and after some modifications in the five-phase design, it had 17% lower torque ripple than the three-phase machine. Moreover, during a fault, the performance of multiphase was much better than three-phase [5]. Advancements in power electronics devices and

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