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Implementation of Space Vector Two-Arm Modulation for Independent Motor Control Drive Fed by a Five-Leg Inverter

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Abstract

This paper presents the implementation of two-arm modulation (TAM) technique for the independent control of a two-induction motor drive fed by a five-leg inverter (FLI). A carrier-based space vector pulse width modulation technique for TAM is proposed to generate switching signals for FLI. Two independent three-phase space vector modulators are utilized to control two motors. The motor drive system applies two separate indirect field-oriented control methods. The stationary voltage outputs from the vector control are synthesized in the three-phase space vector modulator to generate switching signals for FLI. The performance of the independent control of the motors and the voltage utilization factor are likewise analyzed. Simulation and experimental results verify the effectiveness of the proposed method for the independent control of the two-motor drive system. The proposed technique is successfully validated by dSPACE DS1103 experimental work.

Keywords: Five-Leg Inverter, Induction Motor Drive, Two-Arm Modulation, Space Vector Pulse Width Modulation

I. INTRODUCTION

Two or more motors may be used or operated for different applications in industries. Some applications require different speeds and torque operations. Conventional one-motor control drive systems are commonly used for these applications. However, the independent control of two-motor drive systems by a single five-leg inverter (FLI) also fulfills the requirement. The system helps decrease the number of used power switch components to only one DC bus supply and one controller. In addition, the system occupies minimal space and is not complex. The proposed solution is significant mainly for industrial applications that require multiple drive systems, such as six-axis industrial robots, machine tools, and winding machines.

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The five-leg voltage source inverter configuration consists of five parallel legs of paired IGBTs parallel to the DC power supply or DC link capacitor. This configuration has 10 IGBTs compared with the six IGBTs in conventional three-leg inverter systems. In conventional drive systems, 12 IGBTs are required for two-motor operations. One leg is shared with one motor supply in the independent control of two-motor applications. Leg 3 or 5 is normally used as the common leg [1]–[12]. Thus, FLI saves one leg to control two-motor systems compared with conventional motor control methods.

Numerous pulse width modulation (PWM) techniques are employed in FLI topology. Among these methods are dual voltage modulation, modulation block method, inversion table method, and double zero sequence method (DZS) [2], [13]–]16]. DZS is the one of the best methods that enables the arbitrary distribution of the DC link voltage between two motors to maintain the operation in constant switching frequency mode. In addition, DZS is simple and easy to implement using standard DSP. This method can overcome the drawback of previous PWMs, such as the restriction of 50% of the DC bus voltage for one motor, asymmetrical