Available online at www.sciencedirect.com

ScienceDirect

Energy Procedia 117 (2017) 361–368

Energy Procedia

www.elsevier.com/locate/procedia

1st International Conference on Power Engineering, Computing and CONtrol, PECCON-2017, 2-4 March 2017, VIT University, Chennai Campus

Improved Performance of Modular Multilevel Converter for Induction Motor Drive

Preeti V. Kapoor[a], Mohan M. Renge[b,*]

[a]Assistant Professor, Ramdeobaba College of Engineering and Management, Nagpur-440013, India

[b]Professor, Ramdeobaba College of Engineering and Management, Nagpur-440013, India

Abstract

Multilevel converters provide an attractive solution to bring the benefits of speed-controlled rotational movement to high-power application. The Modular Multilevel Converter (MMC) is an improved multilevel converter topology preferred for high power applications in recent years. This paper presents an approach to improve performance of MMC for control of Induction Motor (IM) Drive. Experimental results of three phase MMC controlling ac drive are presented. Switching pulses are generated using Digital Signal Processing DSP *TMS*320*F*2812. Performance evaluation of MMC is measured through Weighted Total Harmonic Distortion (WTHD). Simulated results of both Sinusoidal Pulse Width Modulation technique (SPWM) and Selective Harmonic Elimination Pulse Width Modulation (SHE-PWM) technique are compared. FFT analysis shows that lower order harmonics can be eliminated with less switching frequency using SHE-PWM. Result shows that WTHD for line current and line voltage reduces using SHE-PWM technique as compared to SPWM technique for same switching frequency, which will be helpful in reducing the losses and improving motor efficiency.

Peer-review under responsibility of the scientific committee of the 1st International Conference on Power Engineering, Computing and CONtrol.

Keywords: ***Modular Multilevel Converter; DSP; SPWM; Induction Motor; Selective Harmonic Elimination technique; Weighted Total Harmonic Distortion.***

* Corresponding author. Tel.: +91 9823886479.
E-mail address: kapoorpv@rknec.edu

1876-6102 © 2017 The Authors. Published by Elsevier Ltd.
Peer-review under responsibility of the scientific committee of the 1st International Conference on Power Engineering, Computing and CONtrol.
10.1016/j.egypro.2017.05.146

1. Introduction

With the advancement in Power Electronics, control and estimation of induction motor drives are becoming popular. Voltage sourced converters can build up a three-phase AC voltage via a DC-voltage. It uses semiconductors such as IGBTs with turn-off capabilities in order to control the DC-voltage into a sinusoidal behaviour. The most common types are two or three level technologies, with two and three voltage levels respectively. The so-called "multilevel "starts from three levels. Various topologies of multilevel inverter have emerged as the solution for working with higher voltage levels [1,2,3,4,5].

The MMC has become the preferred topology for use in high power applications in recent years. MMC is an improved multilevel converter topology introduced by A. Lesnicar and R. Marquardt in [6, 7] and its development in [8,9] as compared to conventional multilevel converters in medium voltage applications. MMC employing half bridge concept can be suitable for speed control of three phase induction motor

In this work, Digital circuit is used to control three phase MMC. The SPWM waveform is generated by using *DSPTMS320F2812.* MATLAB simulation has confirmed the operation of three phase MMC. The experimental results on laboratory prototype of three phase MMC controlling three phase Induction Motor are compared with simulated results.

Further analysis is also done using SHE-PWM technique to eliminate the lower order harmonics like 5^{th}, 7^{th},11^{th} and 13^{th}.The transcendental non-linear equations are solved using Newton- Raphson method. The Newton-Raphson method is commonly used to solve the non-linear SHE equation. The calculated switching angles are then used to trigger switching devices. MATLAB Simulink model was developed and harmonic analysis is carried out. The performance estimation of MMC is measured through WTHD. Generally Total Harmonic Distortion (THD) and WTHD are two important indices to measure quality of output voltage. Presence of inductance in stator leakage reactance of IM causes higher order current harmonics to die out more easily. THD ignores this difference and treats all harmonics equally. However, WTHD gives a better measure of harmonic effluence by using the order of each harmonic component as its weight factor.

2. Modular Multilevel Converter

Main technical and economic aspects for the development of multilevel converter are modular realization, multilevel waveform, high availability, failure management and investment and life cycle cost.

So as to fulfil the above-mentioned requirement, a modular multilevel converter solely comprising of an arbitrary number of identical submodule was a prerequisite [7].

2.1. Basic Principle of Operation

The basic structure of submodule is shown in Figure 1. It shows the common emitter configuration. Each bidirectional switch requires a gate driver circuit. This Half Bridge Module (HBM) consists of DC voltage equal to V_{dc} with two bidirectional switches S_R and S_F. It is clear that both switches S_R and S_F cannot be ON simultaneously because a short circuit across the voltage V_{dc} would be produced [6,7]. It is noted that two values can be achieved for V_X. When the IGBT S_F is switched on voltage V_x= 0. To apply the voltage V_{dc} to the terminals, the IGBT S_R has to be switched on.

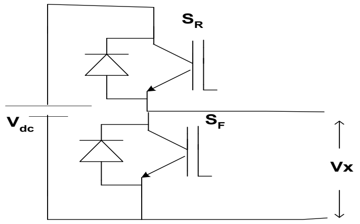

Figure 1Structure of submodule