Asymmetrical Two-Phase Induction Motor Speed Controlled by Multilevel Inverter Employing Cascaded Transformers

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Abstract - **This research presented multilevel inverter using cascade transformers to supply the output voltage levels which are used to control speed of asymmetrical two-phase induction motor. Two sets of full bridge inverters and transformer with difference of number of turn ratio are combined to generate the voltage levels to supply each winding of asymmetrical two-phase induction motor. Triangular multicarrier sine pulse width modulation signal was generated by Arduino Due AT91SAM3X8E microcontroller and IC number IR2130 was used for power circuit. Multilevel inverter was presented to use a low level of input voltage as multilevel of output voltage is high that voltage stress on switches are reduced. The experiment shows the result of speed controlled by volt per hertz constant so as to be sure steady torque and PI method technique was used to closed-loop control.**

Keywords ***Multilevel Inverter, Triangular Multicarrier SPWM, Cascade Transformers, PI Control.***

I. INTRODUCTION

During those years ago, Multi-level inverters have presented a variety of forms. The general principle is to create each of continued voltage levels which are generated by the switching devices switched to combination or subtraction of momentary voltage created by the capacitor voltages [1, 2]. Consequently, the output voltage can be synthesized with stepped waveforms. In addition, the output voltage is high level, but the voltage across the switches is low level then the voltage stress on the power switching devices is reduced, increasing of the power, and generating the high quality output voltages and sinusoidal currents. These advantages of multilevel inverters have attracted an interest in industry [3]-[8].

Commonly, Conventional multilevel inverter topologies have Diode-Clamped or sometimes called Neutral-Clamped [9], Capacitor-Clamped [10], and Cascade H-Bridge cells with separated DC source [11]. Although the mentioned multilevel inverters have a variety of advantages, at that time, the drawbacks of them due to their complexity of structures as follows; [1]

(1) Increased level of voltage, power switching devices with their voltage source, and other passive,
(2) Complexity problem of the circuit configuration,
(3) Complexity problem of the control algorithm,
(4) Lower switch utilization ratio.

Thus, in order to obtain the output voltage level which high quality output voltage waveform by method of multilevel inverter should be solve the above mention problems.

In this research work, multilevel inverter composing two sets of full bridge inverter and transformer with difference of number of turn ratio are combined to generate the voltage levels. The turn ratio of two transformers (primary coil to secondary coil is 1:1 and 1:3) respectively. Two sets of them supply output voltage levels to each winding of asymmetrical two-phase induction motor (ATPIM). The output voltage levels of multilevel inverter are obtained from the circuit switching of switched power devices and addition or subtraction of the transformer terminal voltages while the input voltage is derived from low voltage of the DC power supply.

ATPIM can be modified from single-phase capacitor run motor or permanent split-capacitor (PSC) motor which is widely used in household, buildings and various industrial applications because of the power capacity not very high. Generally, this motor consists of two pieces of winding, one is the main winding and another is called auxiliary winding where both of them conducted at 90 electrical degrees angle to each other and contains different number of winding. Thus it leads to apply the ATPIM [12] when the capacitor is removed from auxiliary winding. Driving ATPIM by multilevel inverter is presented, the results of the experiment show the opened-loop test which frequency is varied. Controlling the speed utilizes the speed control by applying the stability voltage per hertz method in order to obtain the steady torque and the closed-loop control also applies the PI technique.

II. MATHEMATICAL MODEL OF THE ASYMMETRICAL TWO-PHASE INDUCTION MOTOR

The linearity of magnetic circuits, the constant air gap between the stator and rotor and winding of a single phase induction motor, generates a magnetic field distribution that resembles a sinusoidal in the air gap. Various dynamic equations of the motor are more complex

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