Development and Modelling of Three Phase Inverter for Harmonic Improvement using Sinusoidal Pulse Width Modulation (SPWM) Control Technique

Yonis. M. Buswig, Azuka Affam, Hani Albalawi, Norhuzaimin bin Julai, Al-Khalid bin Hj Othman, and Ohirul Qays

Abstract: ***This paper describes the design of a 400 V, three-phase voltage source inverter system using Sinusoidal Pulse Width Modulation (SPWM) control technique. Pulse Width Modulation (PWM) is an internal control technique for inverters. The Sinusoidal Pulse Width Modulation (SPWM) technique is the type of PWM used in this work. The aim is to reduce the harmonic produced by the inverter. Current standards require that total harmonic distortion (THD) be minimal. A three-phase SPWM signal is implemented in order to create an output voltage which is closer to a true sine wave and reduce harmonics. The development and model were implemented using MATLAB Simulink soft-ware and hardware parameters. The addition of a low pass filter circuit aids the achievement of smoother sine waveforms and a reduced THD value of 0.17%. The proposed concept has been validated through experimentally on a laboratory prototype by using DSP TMS320F28335 real-time digital control. The experimental outcomes emphasize the authenticity of the suggested technique in reducing harmonics, which can be promising to power quality improvement.***

Index Terms - Harmonic Improvement; Power Quality Improvement; Sinusoidal Pulse Width Modulation (SPWM); Total Harmonic Distortion (THD); Three-phase Inverter Systems.

I. INTRODUCTION

Power electronics is an advanced technology that involves the control and conversion of electrical power from its input into output form. The power electronics technology from the name itself deals with the transformation of conversion techniques with the help of electronic devices such as power semiconductor devices.

Majorly, there are five types of power electronic circuits which are rectifiers, choppers, inverters, AC voltage controllers and cycloconverters. Each of the five types of power electronic converters carried different purpose. This paper deals with inverters, hence the methodology majorly consists of discussions about the stated subject.

Inverters are widely used in the world to convert direct current to alternating current having variable amplitude and variable frequency. The output voltage of the inverter is controlled by the internal control of the inverter itself and not by controlling the incoming dc output or outgoing ac output to control the output voltage. Pulse Width Modulation (PWM) is the method for the internal control of an inverter [1]. There are various types of PWM control techniques in the three phase inverter such as sinusoidal pulse width modulation (SPWM), third-harmonic injection PWM (THIPWM) and space vector pulse width modulation (SVPWM) [2-3]. The SPWM technique is further discussed in this paper.

The inverter is classified into two types which are voltage source inverter (VSI) and current source inverter (CSI). The classification can be identified by the source or input to the inverter. The inverter is VSI if the source or input is DC voltage which controls the AC output voltage. For the CSI inverter, current is the input and controls the output current.

In this research, the proposed design used the VSI type of inverter for the following reason. As can be compared to the CSI, VSI uses voltage as its input and the value is maintained constant. The current source for the input of CSI is constant but adjustable. The research deals with the three phase inverter where the power semiconductor devices are used. Therefore, VSI type is used because it works with the complicated circuit and with the power semiconductor devices such as the IGBTs used in the research. While for the CSI, it cannot be used because it only works for a simple circuit and cannot with-stand the reverse voltage. VSI has limited or zero impedance at the input terminals that cause the shape of the DC does not easily change while CSI has a high impedance that comes from the DC source current [4].

Inverters are based on the production of the three types of different outputs which are the square wave inverter, the modified sine wave inverter and a pure sine wave inverter.

Revised Manuscript Received on November 15, 2019.

Yonis. M. Buswig, Department of Electrical and Electronic Engineering, Faculty of Engineering Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia

Hani Albalawi, Department of Electrical Engineering, University of Tabuk, Saudi Arabia

Norhuzaimin bin Julai, Department of Electrical and Electronic Engineering, Faculty of Engineering Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia

Al-Khalid bin Hj Othman, Department of Electrical and Electronic Engineering, Faculty of Engineering Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia

Azuka Affam, Department of Electrical and Electronic Engineering, Faculty of Engineering Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia

Ohirul Qay Department of Electrical and Electronic Engineering, Faculty of Engineering Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia