

Three-phase Inverter Using Microcontroller for Speed Control Application on Induction motor

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Abstract - This paper presents a PWM-controlled three-phase inverter designed for controlling the speed of a three phase induction motor. Inverter has very important role as a power conditioning on the electric power system and industrial field. The speed of the induction motor can be controlled by changing the voltage frequency input of the induction motor. The three phase inverter is implemented by using a Power MOSFET and the PWM signal is generated by a Microcontroller. The inverter performance is measured by simulation and experimental test. Inverter circuit is simulated using PSpice software to investigate the inverter behavior and performance. The testing is conducted using two induction motors with different rpm specification. The testing result shows that the Microcontroller can control well the motor speed in no-load mode with various speed references.

1. INTRODUCTION

Induction motor is the most widely electrical machine used in industry, due to its simple construction, sturdy, cheap, and easy maintenance. The induction motor have shifted the use of DC motor in the industry. However, induction motor has several parameters that are non-linear, especially the rotor resistance which varies for different operating conditions. It causes speed control on induction motor is more difficult in comparison with speed control on DC machine.

Common application of induction machine is for constant speed rotation by direct connection to the grid, rotor speed is determined by the grid system frequency. For variable speed application of induction motor, power conditioning device is required [1].

Speed control of an induction machine can be made by any change of pole number or input voltage frequency of induction motor. However, changing of its pole number is unfractical. Changing of input voltage frequency is realized by using a power conditioning or inverter. The use of inverter is a simple and easy way for controlling speed of induction motor and it has been broadly used on industry application [2],[3].

Inverter converts DC voltage into AC voltage where magnitude and frequency voltage can be varied as required. AC voltage generated is a square waveform or trapezoid. The application of filter device is required to produce pure sinusoidal waveform.

Voltage output regulation of inverter can be done in two ways. First, by adjusting the DC input voltage but the switching frequency is constant. Second, by adjusting the switching frequency while the DC input voltage is constant. In the second method, the effective AC voltage generated is a function of the pulse width of the switching. Now is called Pulse Width Modulation (PWM). [2]

II. THREE-PHASE INVERTER CIRCUIT

The basic circuit of three-phase inverter is presented in Figure 1. It has two capacitors to generate N points for each capacitor voltage $V_i / 2$ remains constant. There are three sides of the switch, namely: switch S1 and S1 + S2 + and S2- as well. Both sides of the switch, the switch S1 and S4, S3 and S4, and S5 and S2. Each switch, S1 and S4, or S3 and S4, or S5 and S2, can not operate simultaneously, because there will be short circuit. ON and OFF from both sides of the switch is determined by the PWM modulation technique [4],[5].

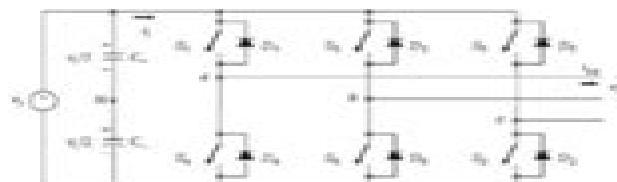


Figure 1. Three phase Inverter Circuit

To produce the output voltage (V_o) in three phases, eight switching conditions configuration as shown in Table 1 should be applied.

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PWM Control of a Three Phase Inverter Using a Microcontroller Mohd Zaidi Sofian,1998 Microelectronics, Electromagnetics and Telecommunications Ganapati Panda,Suresh Chandra Satapathy,Birendra Biswal,Ramesh Bansal,2018-11-02 The book discusses the latest developments and outlines future trends in the fields of microelectronics electromagnetics and telecommunication It contains original research works presented at the International Conference on Microelectronics Electromagnetics and Telecommunication ICMEET 2018 organised by GVP College of Engineering A Andhra Pradesh India The respective papers were written by scientists research scholars and practitioners from leading universities engineering colleges and R D institutes from all over the world and share the latest breakthroughs in and promising solutions to the most important issues facing today s society Information and Communication Technology for Competitive Strategies (ICTCS 2020) Amit Joshi,Mufti Mahmud,Roshan G. Ragel,Nileshsingh V. Thakur,2021-07-26 This book contains the best selected research papers presented at ICTCS 2020 Fifth International Conference on Information and Communication Technology for Competitive Strategies The conference was held at Jaipur Rajasthan India during 11 12 December 2020 The book covers state of the art as well as emerging topics pertaining to ICT and effective strategies for its implementation for engineering and managerial applications This book contains papers mainly focused on ICT for computation algorithms and data analytics and IT security Smart Grids for Smart Cities, Volume 1 O. V. Gnana Swathika,K. Karthikeyan,Sanjeevikumar Padmanaban,2023-07-05 SMART GRIDS for SMART CITIES Written and edited by a team of experts in the field this first volume in a two volume set focuses on an interdisciplinary perspective on the financial environmental and other benefits of smart grid technologies and solutions for smart cities What makes a regular electric grid a smart grid It comes down to digital technologies that enable two way communication between a utility and its customers as opposed to the traditional electric grid where power flows in one direction Based on statistics and available research smart grids globally attract the largest investment venues in smart cities Smart grids and city buildings that are connected in smart cities contribute to significant financial savings and improve the economy The smart grid has many components including controls computers automation and new technologies and equipment working together These technologies cooperate with the electrical grid to respond digitally to our quickly changing electric demand The investment in smart grid technology also has certain challenges The interconnected feature of smart grids is valuable but it tremendously increases their susceptibility to threats It is crucial to secure smart grids wherein many technologies are employed to increase real time situational awareness and the ability to support renewables as well as system automation to increase the reliability efficiency and safety of the electric grid This exciting new volume covers all of these technologies including the basic concepts and the problems and solutions involved with the practical applications in the real world Whether for the veteran engineer or scientist the student or a manager or other technician working in the field this volume is a must have for any library **ICSEDTI 2022**

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Advances of Science and Technology Mulugeta Admasu Delele,Mekuanint Agegnehu Bitew,Abebech Abera Beyene,Solomon Workneh Fanta,Addisu Negash Ali,2021-07-14 This two volume set constitutes the refereed post conference proceedings of the 8th International Conference on Advancement of Science and Technology ICAST 2020 which took place in Bahir Dar Ethiopia in October 2020 The 74 revised full papers were carefully reviewed and selected from more than 200 submissions of which 157 were sent out for peer review The papers present economic and technologic developments in modern societies in 6 tracks Chemical food and bio process engineering Electrical and computer engineering IT computer science and software engineering Civil water resources and environmental engineering Mechanical and industrial engineering Material science and engineering **IEEE International Symposium on Industrial Electronics Proceedings** ,2003 **The Customer Satisfaction towards Service Quality of Electrical Equipments** E. Sankaran, Dr. K S Meenakshi Sundaram, Dr. D Kirubakaran, **Frontiers of ICT in Healthcare** Jyotsna Kumar Mandal,Debashis

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Power Electronics Design Handbook Nihal Kularatna,1998 Power Electronics

Design Handbook covers the basics of power electronics theory and components while emphasizing modern low power components and applications Coverage includes power semiconductors converters power supplies batteries protection systems and power ICs One of the unique features of the Power Electronics Design Handbook is the integration of component and system theory with practical applications particularly energy saving low power applications Many chapters also include a section that looks forward to future developments in that area References for further information or more in depth technical reading are also included Nihal Kularatna is a principal research engineer with the Arthur C Clarke Foundation in Sri Lanka He is also the author of Modern Electronic Test and Measuring Instruments published by the Institute of Electrical Engineers Emphasizes low and medium power components Offers a unique mix of theory and practical application Provides a useful guide to further reading *Advancing Toward Technology Breakout in Energy Conversion ,1986 Microcontroller Based Delta Modulated PMW for Three Phase Inverter* Ayu Annur Fetrah Yusoff,2012

One of the PWM schemes proposed for the control of inverters supplying ac drive is Delta Modulation Presently microcomputer has been used as an alternative to the standard Delta Modulation PWM technique Even though the microcomputer is considered as power computing machine their weakness is that to communicate with peripheral equipments they must use specialized circuit added as an external chips By utilizing the features of microcontroller they can just fit inside other device like the inverter or other appliance and also they does not need any other specialize external component for its application The microcontroller based delta modulated PWM

for 3 phase inverter has been proposed in this project in order to get better solution for the control of inverter The simulation of Delta Modulation techniques is carried out using PROTEUS ISIS 7.0 in order to get six modes of delta modulated PWM switching scheme Then the microcontroller PIC18F4550 circuitry to generate Delta PWM is assembled The circuit from the simulation can produce the necessary Delta PWM signal to control the inverter **IETE Technical Review**,2000

Standard Handbook for Electrical Engineers Donald Fink,H. Wayne Beaty,2006-09-15 The Standard Handbook for Electrical Engineers has served the EE field for nearly a century Originally published in 1907 through 14 previous editions it has been a required resource for students and professionals This new 15th edition features new material focusing on power generation and power systems operation two longstanding strengths of the handbook that have recently become front burner technology issues At the same time the entire format of the handbook will be streamlined removing archaic sections and providing a quick easy look up experience **Wescon/95** ,1995 **Computational Aspects of Electromechanical Energy Converters and Drives** International Association for Mathematics and Computers in Simulation. International Conference,Réal-Paul Bouchard,Guy Olivier,Ecole polytechnique (Montréal, Québec). Département de génie électrique et de génie informatique,1993

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