IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 2, May 2024

AC PWM Control System in Induction Motor using Microcontroller

Aayush Bahade, Ashish Khonde, Suraj Charduke, Saurabh Wele, Prof. Suyog. S. Dhoke
Department of Electrical Engineering
Rajiv Gandhi College of Engineering Research and Technology, Chandrapur, India

Abstract: *The demand for efficient and precise control of induction motors has led to the development of advanced control systems, among which AC PWM (Pulse Width Modulation) stands out as a prominent technique. This project focuses on the design and implementation of an AC PWM control system for an induction motor utilizing a microcontroller. The system employs a microcontroller to generate PWM signals, controlling the power electronics responsible for modulating the voltage supplied to the motor. The report details the architecture, components, and methodology employed in the project. A comprehensive discussion on the PWM control algorithm, motor drive circuitry, and sensor integration is presented. The microcontroller programming and experimental results showcase the effectiveness of the proposed system in achieving precise control over motor speed and efficiency. The challenges faced during the project are discussed, along with the corresponding solutions implemented. The report concludes with a summary of achievements and suggestions for future enhancements. Overall, this project contributes to the field of motor control systems, offering a reliable and efficient solution for induction motor control through AC PWM with microcontroller integration*

Keywords: PWM

I. INTRODUCTION

Induction motors do not run at synchronous speed, they are generally fixed speed motors. In Industries mechanical loads should not only be driven but should also be driven at desired speed. Therefore, the need of speed control methods for induction motor arises. In the real of industrial automation and electric motor control, the precise regulation of induction motors is crucial for achieving optimal performance and energy efficiency. Induction motors are widely employed in various applications, ranging from manufacturing processes to HVAC systems, and their control plays a pivotal role in enhancing overall system efficiency. Pulse Width Modulation (PWM) has emerged as a powerful technique for achieving variable-speed control in AC induction motors, allowing for fine-tuned adjustments to motor operation. This project focuses on the design and implementation of an AC PWM control system for an induction motor, with the integration of a microcontroller as the central processing unit. The integration of microcontrollers in motor control systems has gained significant traction due to their flexibility, processing capabilities, and ease of programmability. The microcontroller serves as the brain of the system, orchestrating the generation of PWM signals that control the power electronics responsible for modulating the voltage supplied to the induction motor. The significance of this project lies in its potential to offer a reliable and efficient solution for controlling induction motors with a high degree of precision. By employing AC PWM, the system can not only regulate the motor speed but also optimize energy consumption and reduce operational costs. This introduction sets the stage for a comprehensive exploration of the system architecture, components, and methodologies employed in achieving AC PWM control for induction motors using a microcontroller. The subsequent sections will delve into the intricacies of the PWM control algorithm, motor drive circuitry, sensor integration, and the programming aspects of the microcontroller. Through a detailed examination of each element, this project aims to contribute valuable insights into the field of motor control systems, providing a robust foundation for further advancements in industrial automation and electric motor control.

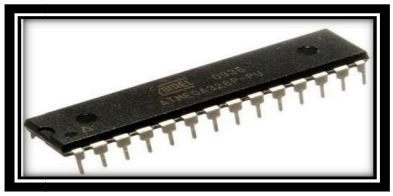
DOI: 10.48175/IJARSCT-18196

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 2, May 2024

1.1. What is ACPWM Control System?

ACPWM control System for Induction Motor: ACPWM control for induction motor is a system, that enables the single-phase ac motor to run at different speeds.

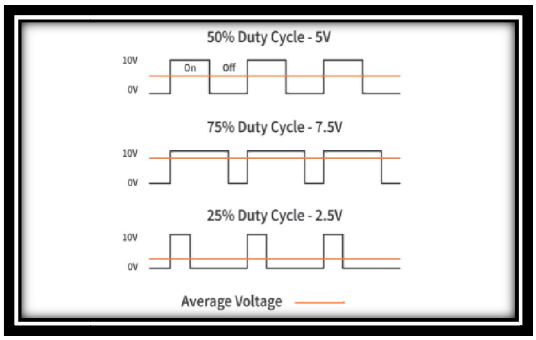
Induction motor speed control is **a process of manipulating currents in an induction motor to regulate speed**. While often used in fixed frequency applications, induction motors are popular for variable frequency applications such as industrial drives and electric vehicles.



Typically, an AC motor controller consists of three basic parts: the rectifier, inverter, and the DC link to connect the rectifier and inverter. **The rectifier converts AC input into DC (direct current), while the inverter switches the DC voltage to an adjustable frequency AC output voltage**.

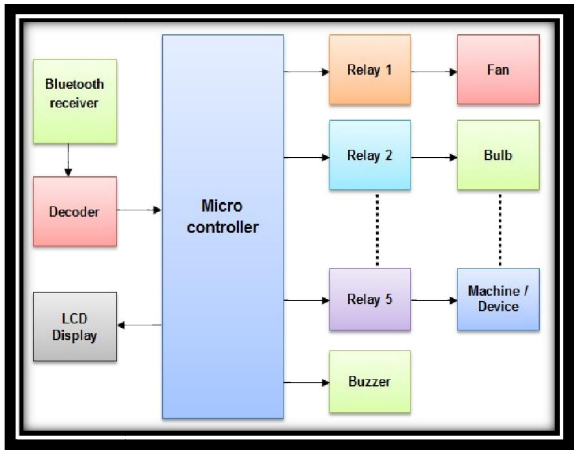
1.2. What are the functions of ACPWM?

The average value (or DC value) of a PWM rectangular wave is proportional to its duty cycle. See below. Components of hybrid inverter



The DC motor acts as a low-pass device (rejects high frequency harmonics) and has a speed proportional to the DC value of the applied voltage. So, if the PWM frequency is high enough, what the motor "sees" in the applied PWM is that average value, or DC value. And adjusts its speed accordingly

1.3. Block Diagram



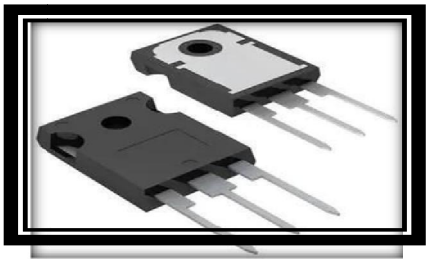
IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 2, May 2024

II. COMPONENT OF AC PWM CONTROL SYSTEM

Microcontroller:

Select a microcontroller suitable for motor control applications, such as Arduino, PIC, or ARM-based microcontrollers. Consider factors such as processing power, communication capabilities, and ease of programming.

Power Electronics:



IGBTs or MOSFETs: Insulated Gate Bipolar Transistors (IGBTs) or Metal- Oxide-Semiconductor Field-Effect Transistors (MOSFETs) are commonly used for voltage modulation in the motor drive circuit.

Gate Drivers: Provide the necessary signals to drive the IGBTs or MOSFETs efficiently.

Motor:

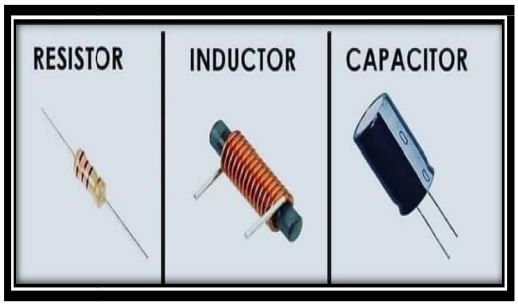
Induction Motor: Select an induction motor suitable for the application, considering factors such as power rating, voltage, and speed requirements.

Motor Drive Circuit Components:

Diodes: Freewheeling diodes to handle inductive loads in the motor drive circuit.

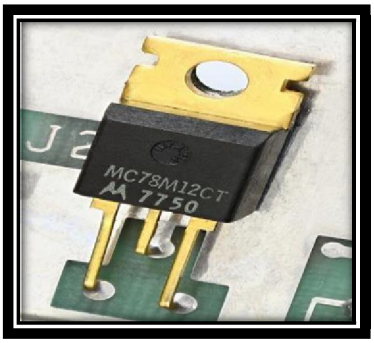
Capacitors and Inductors: Filter components to reduce voltage ripple and smooth the output.

Resistors: Used in various parts of the circuit for current limiting and voltage division.

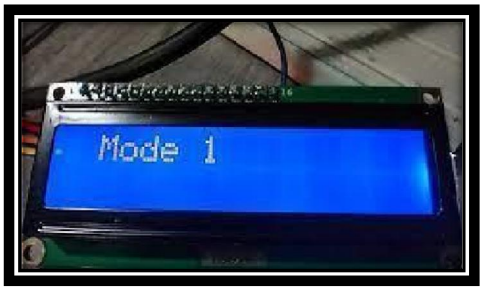


IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 2, May 2024

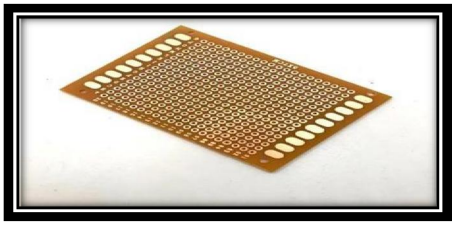
Voltage Regulator:
Use a voltage regulator to provide a stable power supply for the microcontroller and other control circuitry.



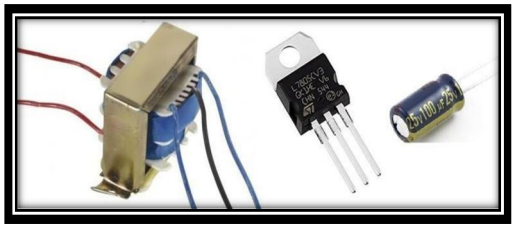
Display and User Interface:
LCD or LED Display: Provide real-time feedback on motor speed, status, or error messages.
User Interface: Buttons, switches, or a touch panel for user interaction and system control.



PCB (Printed Circuit Board):
Design and manufacture a PCB to mount and interconnect the various components systematically.



Power Supply:
Provide a stable and suitable power supply for the entire system.



IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 2, May 2024

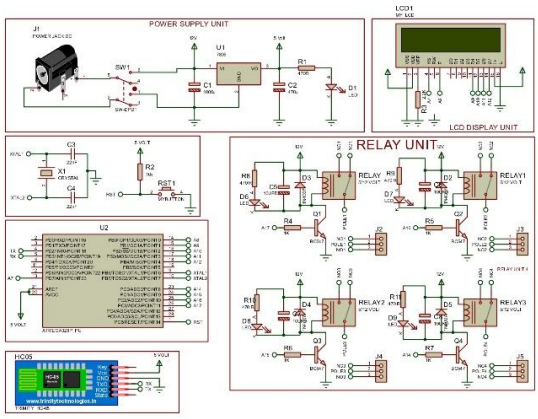
Wiring and Connectors:

Use appropriate wiring and connectors to interconnect the components reliably.

III. WORKING PRINCIPLE

- ACPWM control for induction motor is a system that enables the single-phase AC motor to run at different speeds. This project aims at controlling the AC power by using the concept of firing angle control of thyristors.
- This project uses a new speed control technique for the single-phase AC induction motor. It presents a low-cost design with high-efficiency drive capable of supplying a single-phase AC induction motor with a PWM modulated sinusoidal voltage.
- The circuit operation is controlled by an AVR family microcontroller. The circuit is capable of supplying a single-phase AC induction motor (or general A.C. inductive/resistive load) with varying AC voltage.
- The same as in triac control, the voltage applied to the load can be varied from zero to maximum value.
- On the other side, it uses a pulse width modulation technique (PWM circuit), and when compared with the phase angle control used for triacs, produces much lower high order harmonics.
- It directly modulates the mains a.c. voltage. Compared with costly converter, it requires a lower number of active and passive power components. By the means of range, the speed of induction motor is been increased with the help of button. AC voltage is provided to the load.
- Once it reaches to the maximum voltage which is 230 volts, it starts decreasing. It helps to control the speed of induction motor

Circuit Diagram:



Creating a comprehensive circuit diagram for the motor drive section involves detailing the connections and components responsible for driving the induction motor using PWM. Below is a simplified representation of a motor drive circuit for an AC PWM control system using a micro-controller. Note that the actual design may require additional components or variations based on specific motor and control system requirements.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 2, May 2024

Explanation:

1. Microcontroller:
- Generates PWM signals based on the control algorithm.

2. PWM Output:
- The PWM signals from the microcontroller serve as the input to the gate driver.

3. Gate Driver:
- Amplifies and conditions the PWM signals to drive the IGBT/MOSFET effectively.

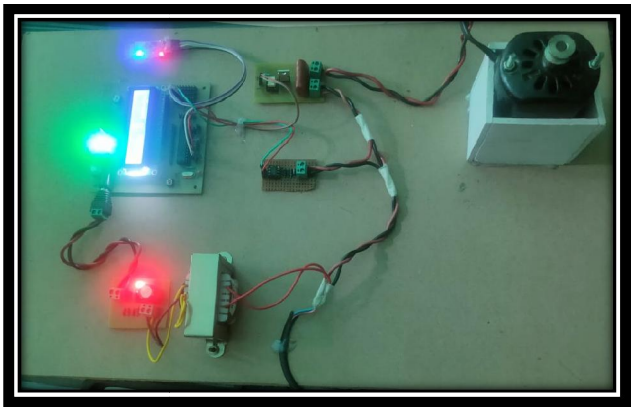
4. Opto-Isolator:
- Provides electrical isolation between the microcontroller and the gate driver for safety and noise reduction.

5. IGBT/MOSFET:
- Act as switches to modulate the voltage supplied to the induction motor.

6. Modulation Logic:
- Controls the switching of IGBTs/MOSFETs based on the PWM signals to regulate the motor voltage.

7. Motor Terminals:
- Connect to the induction motor to deliver the modulated voltage, thereby controlling the motor speed.

This basic circuit diagram illustrates the fundamental components involved in the motor drive section of an AC PWM control system. It's important to consult the datasheets of the specific components used and adhere to safety guidelines during the implementation of the circuit. Additionally, consider including protection mechanisms such as overcurrent and temperature monitoring for safe and reliable operation.



Advantages:

- Low cost
- High efficiency
- Gives Modulated Sinusoidal voltage
- Requires a lower number of active and passive power components.

Disadvantage:

- Working rate of engine fixed (not at all like VFD, recurrence is fixed)
- Speed guideline is unimaginable (utilized for just beginning and halting and assurance)
- Speed increase and deceleration time more rely upon load.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 2, May 2024

IV. FUTURE SCOPE

- Future scope for the AC PWM control system for induction motors using AVR microcontrollers includes:
- Integration of Advanced Control Algorithms: Incorporating advanced control algorithms such as predictive control or adaptive control techniques to enhance the system's performance, efficiency, and robustness in various operating conditions.
- Implementation of Sensor less Control Techniques: Developing sensor less control methods for motor speed and position estimation, reducing hardware complexity, and cost while improving reliability and eliminating the need for additional sensors.
- Integration with IoT and Cloud Connectivity: Enhancing the system's connectivity by integrating with Internet of Things (IoT) platforms and cloud services, enabling remote monitoring, diagnostics, and control of motor systems for predictive maintenance and optimization.
- Application in Electric Vehicles (EVs) and Renewable Energy Systems: Adapting the PWM control system for use in electric vehicles (EVs), renewable energy systems, and smart grids to improve energy efficiency, grid stability, and integration of renewable energy sources.

REFERENCES

[1] Khaled A. Madi Ali and Mohammad E. Salem Abozaed "AC PWM SPEED CONTROL SYSTEM" Proceedings of the International multiconference of Engineers 2010 vol. ll, March 17-19,2010
[2] Harsha P. Pawar, ChavanNehaSarjerao and ShindeAshwiniBalaku "Speed Control of Induction Motor using PWM" Technique Published 4 September 2015 International journal of engineering research and technology
[3] Hamid A. Toliyat, RahulKhopkar, Electric Machines & Power Electronics Laboratory Department of Electrical Engineering Texas A&M University 26 Feb. 2014
[4] "AC PWM CONTROL SYSTEM IN INDUCTION MOTOR USING MICROCONTROLLER"