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 1, March 2024

Automatic Power Factor Compensation using PIC Microcontroller

Prof. Waghchaure S. J.[1], Mr. Irfan Shaikh[2], Mr. Fardin Shaikh[3], Mr, Nitinlagad[4], Mr, Adil Pathan[5]

Professor, Department of Electrical Engineering[1]

Students, Department of Electrical Engineering[2,3,4,5]

Adsul's Technical Campus, Chas, Maharashtra, India

Abstract: *This paper presents the design and implementation of an Automatic Power Factor Compensation (APFC) system using a PIC microcontroller for enhancing energy efficiency in industrial applications. The system aims to mitigate the effects of poor power factor by dynamically adjusting compensation elements to maintain power factor close to unity. Key components of the system include voltage and current sensors, a PIC microcontroller, and power factor correction capacitors. The microcontroller continuously monitors the power factor and controls the connection of capacitors based on real-time measurements. Experimental results demonstrate the effectiveness of the proposed APFC system in improving energy efficiency and reducing electricity costs. The integration of advanced control algorithms and microcontroller technology offers a reliable and cost-effective solution for optimizing power factor in industrial environments*

Keywords: Automatic Power Factor Compensation, PIC Microcontroller, Power Efficiency, Industrial Applications.

I. INTRODUCTION

In industrial settings, the efficient utilization of electrical power is of paramount importance for reducing operational costs and enhancing overall productivity. A significant factor influencing the efficiency of electrical systems is the power factor, which represents the ratio of real power to apparent power in an AC circuit. Ideally, a power factor of unity indicates optimal power utilization, where real power and apparent power are in phase.However, in many practical scenarios, the power factor deviates from unity due to the presence of reactive components such as inductive loads. This deviation leads to inefficient power transmission, increased energy losses, and additional strain on electrical infrastructure. To address these issues, power factor correction (PFC) techniques are employed to adjust the phase relationship between voltage and current, thereby improving the power factor.

Traditional PFC methods involve the use of fixed capacitors or inductors to compensate for reactive power. While effective in some cases, these static compensation techniques are unable to adapt to changing load conditions, resulting in suboptimal performance. Moreover, manual adjustment of compensation elements is often required, leading to increased maintenance efforts and potential inaccuracies.To overcome these limitations, there is a growing interest in the development of automatic power factor compensation systems. These systems utilize advanced control algorithms and real-time monitoring to dynamically adjust compensation elements based on load variations. By employing sophisticated control techniques, automatic PFC systems can maintain the power factor close to unity under diverse operating conditions, thereby optimizing energy efficiency and reducing operational costs.This paper proposes a novel approach to automatic power factor compensation using a PIC microcontroller. The system integrates voltage and current sensors with a PIC microcontroller to monitor the power factor in real-time. Based on the measured power factor, the microcontroller dynamically controls the connection of power factor correction capacitors to achieve near unity power factor. The effectiveness of the proposed system is evaluated through experimental validation, demonstrating its potential for enhancing energy efficiency in industrial applications.

II. LITERATURE SURVEY

[1] Power factor correction (PFC) has been a subject of extensive research and development in the field of electrical engineering, driven by the need to improve energy efficiency and reduce electricity costs in industrial and commercial

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 1, March 2024

applications. The literature review highlights various approaches and methodologies employed in the domain of power factor correction, ranging from traditional static methods to modern dynamic techniques.

[2] Static power factor correction methods have been widely utilized for decades, involving the use of fixed capacitors or inductors to compensate for reactive power in electrical systems. These methods, while effective in improving power factor under steady-state conditions, lack adaptability to dynamic load variations. Furthermore, manual adjustment of compensation elements is often required, leading to inefficiencies and inaccuracies in power factor correction.

[3] .The Automatic Power factor Correction (APFC) device is a very useful device for improving efficient transmission of active power. If the consumer connect inductive load, then the power factor lags, when the power factor goes below 0.97(lag) then the Electric supply company charge penalty to the consumer. So it is essential to maintain the Power factor below with in a limit.

III. PROPOSED SYSTEM

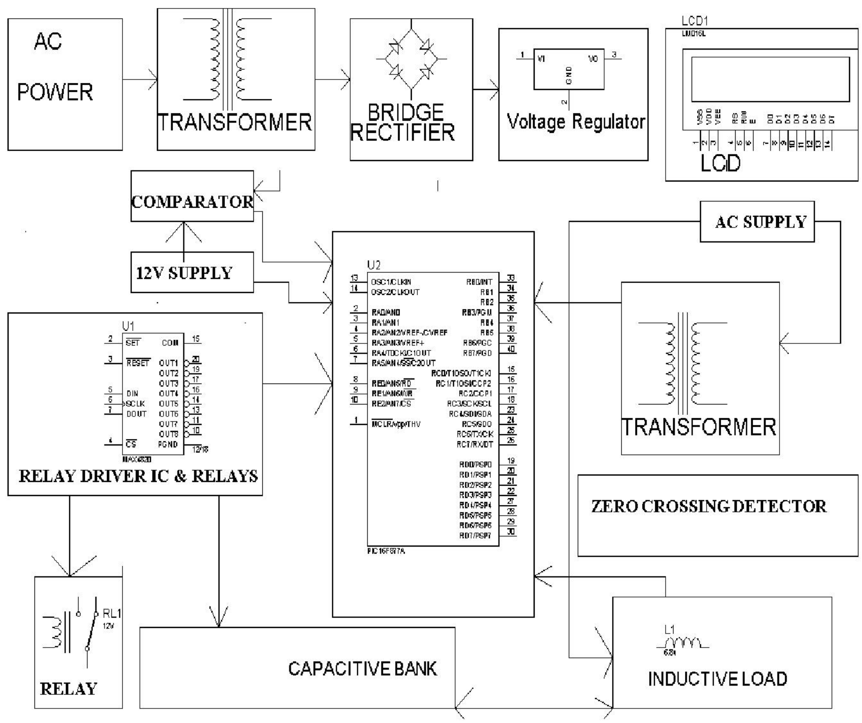

Fig.1 Block Diagram of System

In this block diagram

- Transformer (230V - 12V AC): Reduces the input AC voltage to a lower level suitable for processing.
- Voltage Regulator: Maintains a stable output voltage for the system.
- Rectifier: Converts AC voltage to DC voltage.
- Filter: Smoothens the DC voltage to remove ripples and fluctuations.
- Relay: Controls the connection of power factor correction capacitors based on signals from the microcontroller.
- PIC Microcontroller: Monitors power factor and controls the system's operation.
- Relay Driver: Controls the relay based on signals from the microcontroller.
- Push Buttons: Allows manual control of the system.
- LCD: Displays system information for monitoring and interaction.
- LM339: Used for voltage comparison and generating digital signals.
- Current Transformer: Measures load current for feedback to the microcontroller.

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 1, March 2024

- Inductive Load: Represents the load requiring power factor correction.
- Shunt Capacitor: Improves power factor by compensating for reactive power.
- LED: Provides visual indication of system status.
- 1N4007 / 1N4148: Rectifier diodes for voltage conversion.
- Resistor: Used for various purposes like voltage division and current limiting.
- Capacitor: Used for filtering and power factor correction.

Transformer

Fig 2. TRANSFORMER

The input coil is called the primary and the output coil is called the secondary. There is no electrical connection between the two coils; instead they are linked by an alternating magnetic field created in the soft-iron core of the transformer. The two lines in the middle of the circuit symbol represent the core. Transformers waste very little power so the power out is (almost) equal to the power in. Note that as voltage is stepped down and current is stepped up.

LCD display:

Fig.3 lcd display

[5] The LCD display provides visual feedback to the user. You can use it to display information such as scanned item details, total price, system status, and error messages. To use the LCD display with NodeMCU, you would typically connect it using GPIO pins and control it using the LiquidCrystal library in Arduino IDE.

PIC MICRO-CONTROLLER:

Fig.4PIC Microcantroller

The PIC microcontroller, short for Peripheral Interface Controller, is a popular type of microcontroller developed by Microchip Technology. It is widely used in various electronic devices and embedded systems due to its versatility, reliability, and cost-effectiveness. The PIC microcontroller family encompasses a range of devices with different features and capabilities, catering to diverse application 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 1, March 2024

Push Buttons:

Fig.5 Push button

Push buttons serve as user input devices, allowing the user to interact with the system. You can use push buttons for functions such as navigating menus, selecting items, or confirming actions. Each push button connects to a GPIO pin on the NodeMCU, and you can use internal pull-up or pull-down resistors to detect button presses.

Relay ;

Fig.6 Relay

[5] A relay driver is a circuit or device used to control the operation of a relay. Relays are electromechanical switches that can be used to control high-power or high-voltage circuits with low-power signals. A relay driver ensures that the relay is properly energized or de-energized in response to input signals from a microcontroller, logic circuit, or other control systems.

IV. CONCLUSION

In conclusion, the development of an Automatic Power Factor Compensation (APFC) system using a PIC microcontroller represents a significant advancement in the field of energy management and efficiency improvement in industrial applications. By dynamically adjusting compensation elements based on real-time measurements of power factor, the system ensures optimal power utilization and minimizes energy losses.

The integration of advanced control algorithms and microcontroller technology offers several key benefits, including enhanced accuracy, adaptability to changing load conditions, and reduced maintenance requirements. The PIC microcontroller, with its versatile features and cost-effectiveness, serves as a reliable platform for implementing APFC systems in diverse industrial settings.

Through experimental validation, the effectiveness of the proposed APFC system has been demonstrated in improving energy efficiency and reducing electricity costs. By maintaining power factor close to unity, the system helps mitigate penalties imposed by utility providers and ensures stable operation of electrical systems.

Looking ahead, further research and development efforts can focus on optimizing control algorithms, integrating advanced sensing and monitoring technologies, and standardizing communication protocols for seamless integration with existing power management systems. Additionally, exploring potential applications of APFC systems in other sectors, such as commercial buildings and residential complexes, can contribute to broader adoption and greater impact on overall energy sustainability.

V. ACKNOWLEDGMENT

The satisfaction and euphoria that accompany the successful completion of any task would be incomplete without mentioning the people whose constant guidance and encouragement made it possible. We take pleasure in presenting before you our project, which is the result of a studied blend of both research and knowledge.

We express our earnest gratitude to our internal guide, Professor Anjali Pardeshi, from the Department of Electrical, for his constant support, encouragement, and guidance. We are grateful for his cooperation and his valuable suggestions throughout the project's development.

Finally, we extend our gratitude to all other members who were involved, either directly or indirectly, in the completion of this project. Their contributions have been invaluable, and we are thankful for their efforts.

REFERENCES

[1]. Oskar García, Member, IEEE, José A. Cobos, Member, IEEE, Roberto Prieto, Member, IEEE, Pedro Alou, and Javier Uceda, Senior Member, IEEE "Single Phase Power Factor Correction: A Survey." IEEE TRANSACTIONS ON POWER ELECTRONICS, VOL. 18, NO. 3, MAY 2003.

[2]. Jones, L. D.; Blackwell, D. (1983) "Energy Saver Power Factor Controller for Synchronous Motors", IEEE Transactions on Power Apparatus and Systems, Volume: 5, Issue: 5, Pages: 1391-1394.

[3]. Kulkarni Kaumudi, Kumbhar Pooja, Patil Priyanka, Prof.Madhuri International Namjoshi,"Automatic power factor correction using PIC microcontroller", Engineering Research Journal (IERJ) Volume 2 Issue 1 Page 13-16, ISSN 2395-1621, February 2016.

[4]. Barsoum, Nader (2007) "Programming of PIC MicroController for Power Factor Correction" IEEE Conference on Modeling &Simulation, Pages:19-25.

[5]. https://circuitdigest.com/article/16x2-lcd-display-module-pinout-datasheet.

[6]. https://components101.com/switches/5v-single-channel-relay-module-pinout-features-applications-working-datasheet