ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24APR537

Automatic Power Factor Controller

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Abstract:- Automatic Power Factor Controllers (APFCs) play a crucial role in modern electrical systems by ensuring efficient electrical power and improving power quality. This paper presents a comprehensive overview of the Design, implementation, and performance analysis of an APFC system. The proposed APFC system employs advanced control techniques to regulate the power factor of the electrical load, thereby minimizing reactive power consumption and optimizing overall system efficiency. The design process encompasses the selection of suitable power electronics converters, control algorithms, and sensing techniques tailored to the requirements of an application. The results demonstrate significant improvements in power quality, energy utilization, and system stability, thereby highlighting the practical relevance and applicability of the developed APFC technology.

Keywords:- *Automatic Power Factor Controller (APFC), Power Factor, Current Transformer, Circuit Breaker, Sensors, Display Unit, Load Bank, Power Supply, PCB, Microcontroller.*

I. INTRODUCTION

The power factor is the ratio between the Kw and the KVA drawn by an electrical load where the Kw is the actual load power, and Kva is the apparent load power. It counts how effectively the current converts into functional work output of the individual indicator of the load current on the efficiency of the supply system. In an organization, most of the load is inductive load. The result is a lagging power factor loss and wastage of energy. Which results in high power bills and heavy penalties from electricity boards. If the load is uneven, it is hard to maintain the unity power factor. To overcome APFC, use a panel that maintains a unity power factor. So, in industries, they require automatic power factor control systems. Automatic power factor control system, used for the enhancement of power factor. The power factor proportion is called active power to apparent power. And the critical factor in measuring electrical consumption. Everyone knows how costly electricity has become in the present time.

A. Objectives

➢ *Aim of the Project:*

- The project aims to design and build a panel system that defines the control power factor of the system.
- The automatic Power factor controller Panel maintains the power factor unity of the system. It will automatically switch on the capacitance and feed the reactive power to the system as per the required value.

The main objective of our project is to design and construct a contactor-based system that will help us find power factors automatically. A dip in the Power Factor can attract operational losses and a penalty from the electricity board responsible for the electricity supply. APFC Panels can effectively and automatically manage quickly changing and scattered loads along with the retention of high Power Factor. The target is to design and develop an APFC panel that handles the task described.

II. LITERATURE REVIEW

The data is survey to receive basic ideas and knowledge of the project topic, Automatic Power Factor Controller Panel (APFC Panel).

- StandardPublication International Journal of Innovations in Engineering Research and Technology [IJIERT] ISSN: 2394-3696 Volume 2, Issue 5, May 2015, the topic of Automatic Power Factor Correction published by Gopal Reddy K. This paper presents the control to correct the power factor automatically without any human presence. It automatically increases and decreases in power factor. It also helps the industries to continue even during peak hours. Different parts of the power factor contain the ripple current.
- The International Journal of Engineering Trends and Technology (IJETT) on the topic of“Power Factor Improvement using dual Boost Converter” The author published by Prof. D. D. Ahire.The paper involves simulation of power electronics analysis of the current and voltage waveforms. The Apfc incorporated a breaker switch capacitor bank into a small design using a low-cost sensing element and an intelligent control device. The device provided more accurate voltage control and power factor correction than traditional shunt capacitor bank installation.
- The International Journal of Advance Research and Innovative Ideas in Education on the topic of "Automatic Power Factor control using Arduino UNO" was published by Prof. Kunal Shah.This paper presents a Contactor-based APFC system that can sustain up to the rating of 20-25 Kva of the industrial load. The model will serve the purpose of the variation in power factor and automatically use the matching KVAr. Shuffling presents an intelligent power factor

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compensator that performs the power factor correction without existing harmonic resonance under varying demand conditions.

- In the International Journal of Advance Research(IJAR). The topic of"Automatic power factor correction and monitoring by using microcontrollers" was published byAparna Sarkar and Umesh Hi wase. The topic of this paper is an advanced method of power factor correction that utilizes a microcontroller. As switching of capacitors is done automatically, we get better accurate results of power factor control techniques that make the system stable, and that improves power factor efficiency also increases. The compensator in a power electronic system operating with poor service power factor can be controlled vector-wise by phase and quadrature components of the supply current.
- The International Journal of Innovations in EngineeringResearch and Technology(IJIERT). The topic of Design and simulation of an activepower factor controller using "Boost Converter" was published by Sujata Nazarkar.The decoupling allows for more control freedom by utilizing a freewheeling interval. Current stress was increased by reducing inductor-current ripple and improving current handling capability at heavy loads, demonstrating a fast transient response. Boost PFC converter is much simpler and has better dynamic performance than the PCCM boost PFC converter against load disturbance while maintaining low input-current distortion.

III. METHODOLOGY

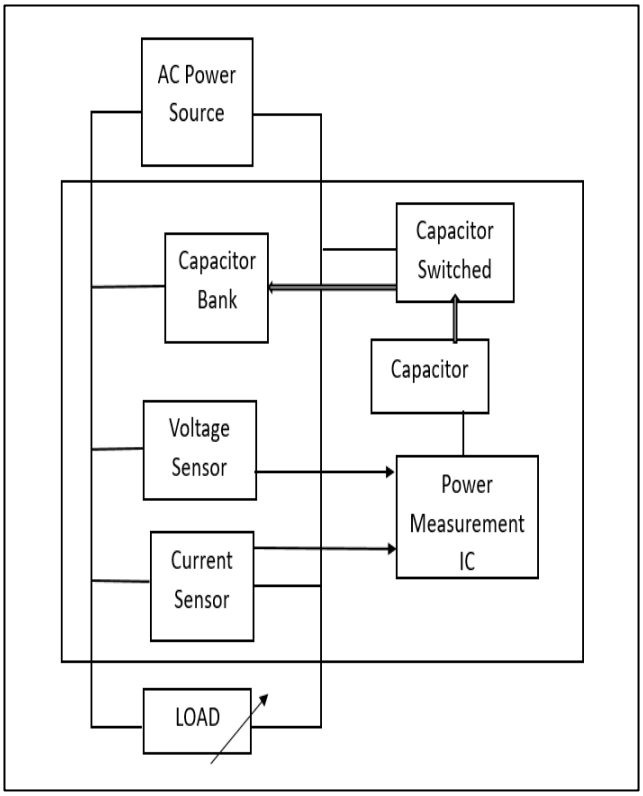

Fig 1: Block Diagram Of APFC

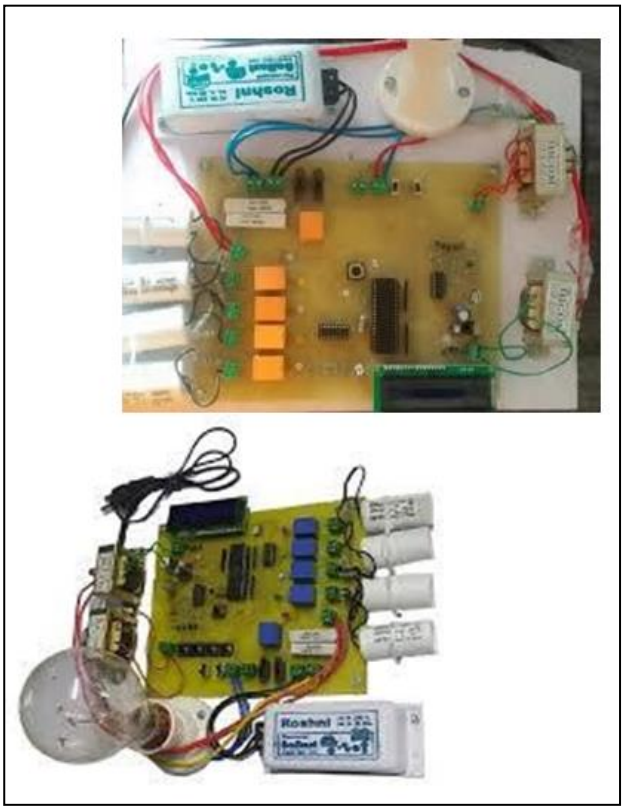

Fig 2: Circuit Design

This diagram illustrates the main components of an APFC system:

- **Voltage Sensor (V sense):** Measures the voltage across the load.
- **Current Sensor (I sense):** Measures the current flowing through the load.
- **Comparator (Error Amp):** Compares the actual power factor with the desired setpoint and generates an error signal.
- **Controller:** Receives the error signal and determines the appropriate corrective action using control algorithms such as PID, fuzzy logic, or adaptive control.
- **Power Electronics Converters:** Modify the reactive power delivered to the load by the controller control signals.
- **Load:** This represents the electrical load, which 1q may be inductive, capacitive, or resistive.

IV. PROPOSED METHODOLOGY

- The controller can receive two signals (voltage and current) from the line when using a current transformer. The power factor is low when the load is inductive.
- The current is behind the voltage by a significant angle because of the low power factor. The controller calculates the phase angle between these two signals by measuring the time interval with a timer. The controller calculates the power factor by formula (Cos X phase angle). After that, it calculates the required compensation.

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- The controller acts as the brain of the circuit; it performs all the mathematical operations.
- When the difference is detected, the controller closes the contactors, which act as a switch between the capacitor and the supply.
- Required capacitors are added to the system to improve the power factor of the load.
- Adding capacitors results in an increase in the power factor to the desired value.
- The controller panel display shows the improved Power factor.
- Disconnecting the capacitor from the load side and discharging the remaining charge into the resistor occurs when the power factor is improved.
- Failure to discharge the capacitor may result in damage and shock.

V. SYSTEM DEVELOPMENT

➢ *Requirement Analysis:*

- Understand the power consumption patterns and requirements of the electrical system.
- Determine the target power factor and reactive power compensation needed to improve power efficiency. Identify the types of loads and their varying power factor characteristics.

➢ *System Design:*

- Consider voltage levels, load types, and system capacity when designing the APFC system architecture.
- Choose the suitable components, like capacitors, reactors, contactors, and controllers, according to the system requirements.
- Design the control algorithm for automatic adjustment of power factor correction.

➢ *Controller Selection:*

- Choose a suitable controller that can monitor the power factor in real time and control the switching of capacitors accordingly.
- Consider controllers with features like digital signal processing, communication interfaces, and protection mechanisms.

➢ *Sensor Integration:*

- Integrate sensors such as voltage and current transformers or transducers to measure parameters like voltage, current, and power factor.
- Effective control requires accurate and reliable sensor readings.

➢ *Capacitor Bank Design:*

- Design the capacitor bank to provide the required reactive power compensation. Determine the number of capacitor stages and their ratings based on load variations and power factor correction needs.

➢ *Control Strategy Development:*

- Develop control algorithms to continuously monitor the power factor and activate/deactivate capacitor stages accordingly.
- Implement strategies to prevent rapid switching and minimize wear on the switching devices.

➢ *Safety Features Implementation:*

- To ensure system components are safe, include safety features such as overcurrent protection, overvoltage protection, and short-circuit protection.

➢ *Testing and Validation:*

- Conduct comprehensive testing of the APFC system under various operating conditions and load scenarios.
- Check the accuracy of sensor readings, the efficiency of control algorithms, and the reliability of switching operations
- Perform testing in simulated environments and real-world conditions to validate system performance.

➢ *Installation and Commissioning:*

- Install the APFC system at the intended location in the electrical distribution network.
- Configure controller settings, calibrate sensors and verify proper operation.
- Trained personnel on how to operate, maintain, and troubleshoot systems.

➢ *Maintenance and Support:*

- Establish a maintenance schedule for routine inspection, calibration, and servicing of the APFC system.
- Provide ongoing support to address any issues or optimize system performance as needed.

VI. CONCLUSION

➢ *From our Project, We Observed that this APFC Panel will Help us in Finding*

- Raising the power factor has been proven to help utilities and end users use electricity more efficiently.
- It reduces the consumer's electricity bills.
- It also helps to reduce the cable size and circuit breaker size.
- It can concluded that the power factor correction technique can be applied to industries, power systems, and households to ensure their stability, resulting in the

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system becoming stable and the efficiency of the systems and apparatus increasing. If the compensator rating is less than the load observed by the detected power, it will improve the power given by the AC supply and reduce the power consumption. Better power quality is achieved by reducing the apparent power drawn from the AC supply and minimizing the power transmission losses. Hence, the efficiency of both the systems and apparatus increases.

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