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AUTOMATIC POWER FACTOR CONTROLLER

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Abstract: An Automatic Power Factor Controller (APFC) is a device designed to automatically adjust the power factor of an electrical system to near unity, thereby enhancing energy efficiency and reducing operational costs. The power factor indicates the phase difference between voltage and current in an AC circuit; a value closer to 1 signifies efficient power usage. The primary goal of this project is to design and implement an APFC system that continuously monitors and corrects the power factor of an electrical network. This correction is achieved by automatically switching capacitor banks in and out of the circuit, compensating for reactive power and ensuring optimal power factor levels.

Keywords: Automatic Power Factor Controller (APFC), Energy Efficiency Capacitor Banks, Power Factor, Inductive Load,

I. INTRODUCTION

Depending on the type of load using the power, multiple components make up the current and, consequently, the power in every AC system. These components are capacitive, inductive, and resistive. When the load is purely resistive, such as incandescent lighting, electrical resistance heating, etc., the current and the voltage are in phase, meaning the current comes after the voltage. However, because the current is out of phase with the voltage in the case of inductive loads, it lags behind the voltage. Nowadays, a large number of consumer appliances and equipment are inductive in nature, with the exception of synchronous motors and a few purely resistive loads. Examples include choke coils, magnetic systems, welding machines, electric arc and induction furnaces, transformers, regulators, and inductive motors of all kinds. When there is a capacitive load, the current now leads the voltage even if the voltage and current are still out of phase. Capacitors put in a system to rectify the load's power factor are the most common and maximum capacitive loads. Reactive loads are often defined as either inductive or capacitive loads. These various load types are significant because only the resistive component of the load, where the voltage and current are in phase, may consume active (or true or useful) power. Reactive power, which is necessary to power or activate the equipment's magnetic circuit (and as a result, not available for any capable work). Reactive power is needed to maintain the electromagnetic field, while working/active power is needed to handle the actual task of producing heat, light, motion, motor outputs, etc. To create the magnetic field surrounding an electric motor, watt-less current is needed. An electric motor would not turn if there was no wattles current. The fact that we can occasionally have excessive watt-less current is what caused the error; in these situations, we must remove part of it.

II. LITERATURE SURVEY

The data is survey to receive basic ideas and knowledge of the project topic, Automatic Power Factor Controller Panel (APFC Panel). Standard Publication 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. Chetan Kidile, Payal Kadu Dinesh Thakare, Rushank Haral , Tejal Kadukar: From the literature survey, we've got determined that because of contemporary-day-day improvement withinside the commercial quarter the call for the strength has been multiplied extremely. There is a greater strength call for arises because of the masses in industries. An electric load may be categorized into 3 sorts and they're resistive load like filament lamp, capacitive load like motor starter.Keith Harker (1998): Power machine reliability and protection are enormously dependent on the practices hired in each commissioning and preservation process. Both ought to be to an excessive fashionable to make sure that the system does now no longer input carrier with latent deficiencies. This needs engineers who recognize the vital control worried in addition to the technical processes.

III. PROPOSED SYSTEM

The automatic power factor correction device is built up using a microcontroller IC, which converts voltage and current samples into square waves using a zero crossing detector. The microcontroller receives load current and signals to the relay driver, which connects the capacitor as per the requirement. The voltage and current sample signal are provided at INT 0 and INT 1, and the difference between the starting waveforms indicates the phase angle difference.

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The internal timer measures the difference with high accuracy, and the power factor is calculated. The power supply is a step down transformer, which transforms power from one circuit to another. The rectifier converts AC voltage to DC output, and the voltage regulator converts the variable output DC voltage into a constant DC voltage. The zero crossing detector detects sine wave zero crossing from positive to negative half cycles, and the output state changes when the input signals pass through zero to positive or negative directions. The LCD, a flat panel display, displays the present power factor.

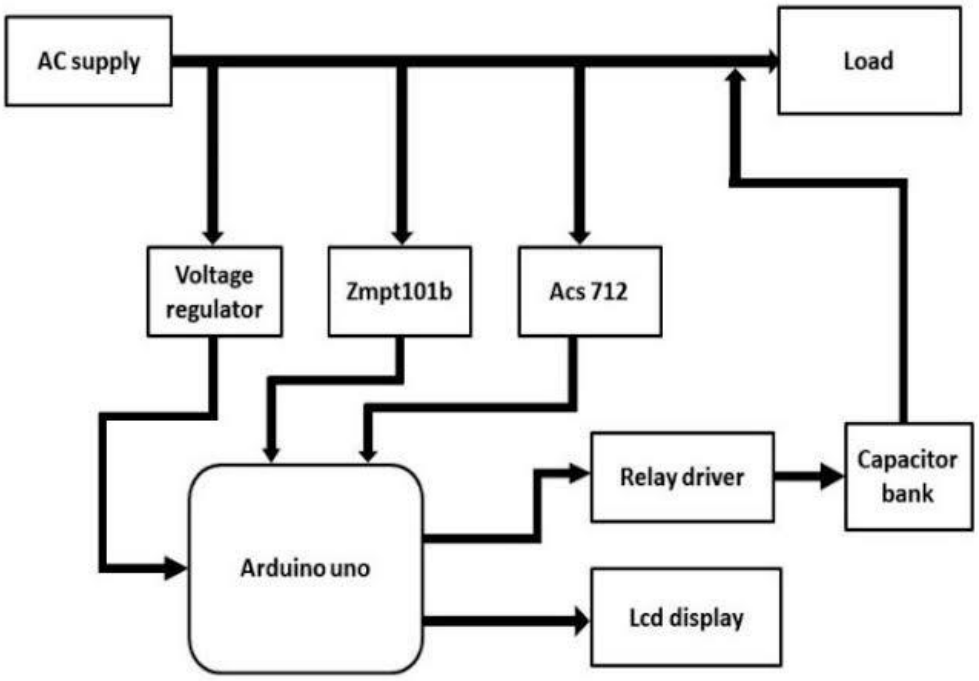

Fig .1 Block Diagram of Automatic Power Factor Controller

IV. HARDWARE DESCRIPTION

This project consists of the following components.

a) Arduino Uno R3
b) Rectifier
c) Power Supply (5V to 12V)
d) Relay 12V
e) LCD (16x2)
f) Chock
g) LED
h) Resistor
i) Capacitor Bank
j) Current Sensor
k) Transformer (12 0 12)

A) Ardunio uno R3

Arduino UNO is a microcontroller board featuring the ATmega328P chip. It includes 14 digital input/output pins, with 6 capable of PWM outputs, and 6 analog inputs. The board operates with a 16 MHz ceramic resonator and can connect via USB, power jack, or AC-to-DC adapter. It has an ICSP header and a reset button. You can easily power it up and start working on your projects. If you make a mistake, you can replace the chip for a small cost and try again.

B) Rectifier-

A rectifier is a device that changes alternating current into direct current. It uses one or more P-N junction diodes, which act like one-way valves to let current flow only in one direction. This change is called rectification.

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C) Relay 12V-

A 12V relay functions as an electrically operated switch, allowing a low-power control signal to manage high-power devices. When a 12V current is applied to the relay's coil, it generates a magnetic field that moves an internal switch, either opening or closing the connected circuit. This switching mechanism enables the relay to control devices like motors, lights, or other high-voltage equipment using a small 12V signal, providing electrical isolation and safe switching between the control and load circuits.

D) LCD(16x2)

For text-based output in embedded systems, a 16x2 LCD (Liquid Crystal Display) is a straightforward display module that can display up to 16 characters on two lines. It works by having a microcontroller send it ASCII data, which is then processed to show the appropriate characters on the screen. Control pins RS, RW, and EN are used by the display to manage commands and data flow, enabling effective communication between the LCD and the controller. Furthermore, it usually has a backlight for better visibility in dimly lit areas. In electronics projects, this kind of display is frequently used to show real-time data, such sensor readings or status messages.

E) Choke-

A choke coil uses self-induction to provide resistance to AC circuits while allowing DC current to pass without resistance. Lentz's law is key to how the choke coil operates.

F) LED-

When an electric current passes through a semiconductor device called a light-emitting diode (LED), light is released. It works on the basis of electroluminescence, in which light is produced when electrons recombine with material holes. Because LEDs are more energy-efficient than conventional bulbs and produce less heat, they can be used in a variety of settings,

G) Resistor-

A resistor is an electrical component that provides resistance, expressed in ohms, to restrict the flow of electric current in a circuit. It follows Ohm's Law ($V = I \times R$) and transforms electrical energy into heat. In electronic circuits, resistors are crucial for splitting voltages, regulating current, and safeguarding delicate parts.

H) Capacitor Bank-

Automatic Power Factor Correction (APFC) is a system that improves electrical installations' power factor, enhancing energy efficiency and reducing costs. It consists of multiple capacitors that automatically switch on or off based on load reactive power demand, balancing inductive loads, reducing current, and minimizing losses.

I) Current Sensor -

An electronic gadget called a current sensor is used to gauge how much current is passing through a wire or circuit. Electrical systems can be monitored, controlled, and safeguarded with the help of the real-time data these sensors give. Current sensors come in a variety of forms, each intended for a particular use.

J) Transformer-

A transformer is an electrical device that uses electromagnetic induction to move electrical energy between two or more circuits. Its main function is to step up (step down) or step down (step up) voltage levels between circuits while maintaining a steady frequency. Transformers are essential parts of electrical power transmission and distribution systems.

V. ADVANTAGES

✓ Improved power factor for better energy efficiency.
✓ Reduced electricity costs by avoiding penalties for low power factor.
✓ Increased system capacity without additional infrastructure.
✓ Lower transmission losses due to reduced current flow.
✓ Enhanced voltage stability in the power network.
✓ Extended equipment lifespan by reducing electrical stress.
✓ Environmentally friendly with lower energy wastage.

VI. RESULT

In order to provide continuous power factor correction without the need for human capacitive bank loading the "automatic power factor corrector using capacitive load bank" project was created. For a switch-mode power converter with any topology (buck, boost, or other), a plc. controller offers peak current limitation and power factor correction.

VII. CONCLUSION

To sum up, Automatic Power Factor Correction (APFC) systems are critical to improving electrical systems' energy efficiency and lowering operating expenses. APFC systems contribute to decreased energy waste, cheaper electricity costs, and longer equipment lifespans by automatically controlling and optimizing the power factor. APFC systems are a great addition to commercial and industrial buildings because of their long-term advantages, which include reduced environmental impact, increased system capacity, and cost savings, even though they do require an initial investment and careful maintenance.

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