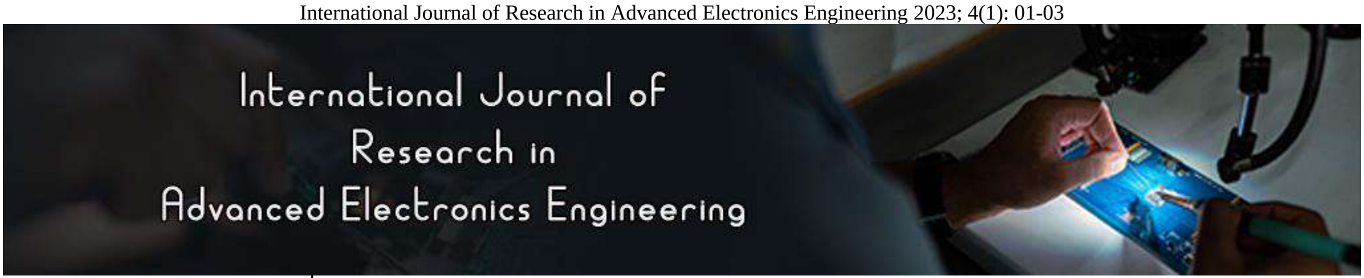

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Automatic power factor correction for micro-scale industry

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Abstract
In an electrical system, the power factor is very important. The power factor of the system can be improved to increase system efficiency. Manually adjusting the correction factor for different loads each time would be tedious, an automatic power factor corrector (APFC) is used to automatically correct the power factor without the need for manual intervention. The project's goal is to create an automatic power factor corrector designed specifically for micro-scale industries.

Keywords: Automatic power factor correction, power factor, capacitor banks

1. Introduction

Industries today overcome various problems and difficulties in various areas paying penalties and spending more on electricity are one of the problems industries are trying to overcome. Industries do need electricity to run the machinery, the issue here is industries are paying excess money for electricity that they have not even utilized for their production. Electrical loads in industries mostly operate on alternating current, this

alternating current contains a reactive component that leads the system to draw more current than its actual capacity this leads to the increase in the flow of current between the load and the source which in turn increases losses in both transmission and distribution side. The loss because of this reactive component results in excess expenses for the industries. Power factor can be expressed as the ratio of the actual power utilized by the load to the apparent power which is flowing through the circuit. The power factor is the reason for the above-stated problem. It plays an important role in an electrical system, showcasing the system's efficiency. The power factor must be kept at the desired amount (0.90 or higher) if not incur additional costs. For a given load, a lower power factor causes more current to flow. Due to this, there is an increase in line current, which leads to an increase in voltage drop in the conductor which results in a lower voltage

The correction of power is very much needed in an electrical system. The power factor must be corrected to unity; by doing so, certain advantages are gained such as the reduction in power losses, and the load capacity of the system can be increased, and with an improved factor the voltage drop in the conductor is reduced.

2. Literature survey

Automatic power factor correction using Reactive power manager relay

The issue of adjusting the power factor of electrical loads is one that arises often in commercial and industrial settings. In the past, power factor correction was accomplished by making adjustments to the capacitance bank using manual means. Power factor correction is best accomplished with the assistance of an automated power factor corrector (APFC) that makes use of a capacitive load bank. The proposed project includes the implementation of an APFC unit, the microcontroller in this unit is utilized for the purpose of determining the power factor value based on the load. The purpose behind the creation of this power factor correction that is continuously adjustable is to guarantee that the whole power system will consistently have a constant power factor. The APFC unit used here is designed for the automatic control of the capacitor banks in (LT) distribution systems. The relay helps in maintaining the system's power factor at the desired value during fluctuations. The relay also delivers the measurement of the system's power factor, voltage, current, and the compensation of reactive power which is needed.

APFC unit thus helps us reduce the time required for power factor correction, which helps increase the efficiency of motors and all inductive loads.

Automatic power factor compensation using zero crossing detectors

To minimalize the penalty in industries the correction unit with zero crossing detectors is used here. The zero-crossing detectors are used to detect the zero crossing of voltage and current. The operational amplifier circuits duly generate the time lag between the zero voltage, they are set to comparator mode which is fed to the interrupter pins of the microcontroller. The relays are actuated to bring the capacitors into the load circuit by the microcontroller through which the power factor is brought near unity. The microcontroller used here belongs to the 8051 families. By using the microcontroller cost is reduced and multiple parameters can be controlled with the availability of the input-output ports and timer.

Automatic power factor controller with GSM

Because of the rise in industrialisation, there has been a growth in the use of inductive loads, which has led to a decrease in efficiency. For fixed loads manual correction can be done, this drawback is overcome with the use of the microcontroller coupled with a GSM module. The GSM module indicates when the required power factor value is not achieved through this method monitoring and message indication are achieved.

Automatic power factor controller with thyristor module

Thyristor switch modules are used in roll mills where fluctuating loads are large in number. The thyristor witch module is equipped with capacitors and reactors which are used for the power factor compensation. This module ensures that the switching is done without delay, it provides inrush current protection. This technique also prevents the generation of voltage spikes and transients.

Automatic power factor correction for industrial loads

When the inductive load grows, the microcontroller included in this design calculates the PWM signal. The purpose of this calculation is to track the compensation rate, activate the capacitors appropriately, and display the compensation stage using an LCD. Equations based on the measured values are used to calculate the power factor compensation for the load. The bypass relay allows uninterrupted maintenance to be done.

3. Proposed work

Numerous initiatives have been created and implemented for the correction of the power factor in industries by employing automatic power factor correction units without manual aid. Using the microcontroller, thyristor module, GSM module, zero detectors along with capacitor banks.

However, the above-mentioned implementations and approaches majorly focus on the usage of microcontrollers, the plan is to implement the APFC unit without the usage of microcontrollers.

The objective of our work is to devise an APFC unit for micro-scale industries. The capacity of compensation that is planned to implement is 25KVAR with four stages of compensation.

The components utilized are

APFC relay: APFC relay is a device that switches the capacitor banks of suitable capacity in multiple stages, this operation is carried out based on the input received from the current transformer. It decides the switching operation and the compensation for each step and actuates the capacitor by initiating the contactor associated with it to keep a reasonably close power factor in the system.

Current transformer: It is a particular kind of transformer used to measure alternating current. Its principal function is to measure current or voltage, both of which have extremely high ratings, and it generates a proportionate alternating current on the secondary side of its windings that is proportional to its primary windings.

Capacity Duty Contactor: The large switching currents of the power capacitors are suppressed by this sort of contactor, which is specifically made for switching the capacitor banks in one or more steps.

Miniature Circuit Breaker: The most important duty of a micro circuit breaker, also known as an MCB, which is an electrical component, is to automatically turn off an electrical circuit when abnormal circumstances, such as an overload or a fault, arise.

Capacitor Bank: A power factor correction assembly is a group of capacitors that work together to improve the power factor.

The phase difference between both the voltage and current is reduced thanks to the capacitors, which results in cost savings. It is used for reactive power compensation to enhance supply quality and improve the efficiency of the system.

4. Working and output

The connection of the components is shown below in Fig 1

The components are:

- Current Transformer
- APFC relay
- Miniature Circuit Breaker
- Capacity Duty Contactor
- Capacitor bank

The power supply from the electricity board is fed into the system, and the current transformer takes in the supply on its primary side and produces an alternating current on the secondary side which is parallel to its primary side.

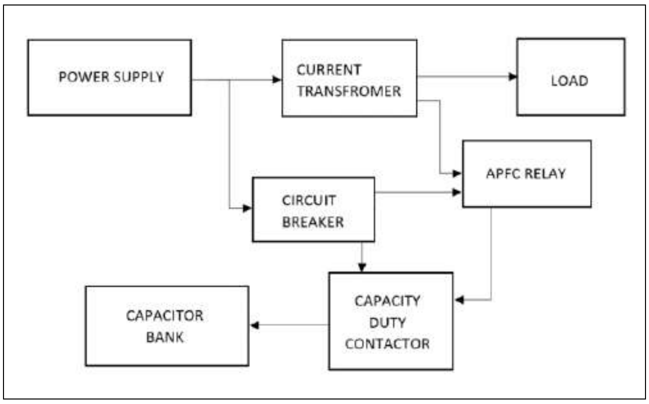

Fig 1: Block Diagram of Automatic Power Factor Correction Unit

From this, the measurement of the current, and voltage of the load. This signal is transmitted to the APFC relay which initiates the capacity duty contactor according to the measured value.

The capacity duty contactor actuates the suitable capacitor from the capacitor bank for the correction of the power factor. The power factor is corrected in various steps with the help of one or more capacitors from the capacitor bank to achieve unity.

5. Conclusion

This paper discusses automatic power factor correction in industries. A system that has a power factor that is lower will have a greater need for current than one that has a power factor that is higher. Correction of power factor results in cost reduction, minimalizing penalties from the Electricity board, increase in the efficiency of the system.

As various techniques of power factor correction are brought into action, the process of correction is carried out with the assistance of capacitor banks which are actuated from the command of the APFC relay. It is anticipated that the power factor of the system would be enhanced as a result of this procedure, as a result of this operation, industries will be able to overcome penalties, and the system's efficiency will be improved.

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