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Power Factor Improvement using APFC Unit

Prof. P. G. Deshmukh [1], Dandgavhal Janhavi Yogesh [2], Garje Harshala Ganpati [3], Gatkal Dhanashri Vikram [4], Gite Akansha Prashant [5].

[1] Lecturer of E&TC Department of MVPS's Rajarshi Shahu Maharaj Polytechnic, Nashik, priya.deshmukh@rsmpoly.org
[2,3,4,5] Student of E&TC Department of MVPS's Rajarshi Shahu Maharaj Polytechnic, Nashik,
[2]janhavidandgavhal@gmail.com, [3] harshalagarje45@gmail.com, [4] vikramgatkal662@gmail.com, [5] giteprashant09@gmail.com

A B S T R A C T

The project is designed to reduce penalties for industrial units by using automatic power factor correction unit. Ratio of real power to apparent power is called as power factor. This definition is often expressed mathematically as KW/KVA, where the numerator is the active (real) power and the denominator is the (active + reactive) or apparent power. Reactive power is non working power generated by magnetic and inductive loads to produce magnetic flux. As reactive power increases, apparent power increases, so power factor also decreases. With a low power factor, the industry requires more energy to meet its demand, thus reducing efficiency. In this proposed system the time lag between zero voltage pulse and zero current pulse is created by suitable operational amplifier circuits in comparator mode are fed to two interrupt pins of the microcontroller.

Keywords: APFC Unit, Thyristor, Electricity Bill, Microcontroller, Capacitor Bank, Current Transformer.

1. Introduction

The concept of the heap consuming the power shapes the current and, consequently, the power in any AC framework. These components are capacitive, inductive, and resistive. In the event of an entirely resistive load—such as an electrical barrier, warmth, bright illumination, etc.—both the flow and the voltage are in stage, meaning that the flow follows the voltage. When inductive loads occur, the current lingers after the voltage, meaning that it is not in sync with the voltage. Almost all modern equipment and devices, such as welding machines, transformers, controllers, and inductive engines of all kinds, are inductive in nature. The current and voltage are now out of phase due to a capacitive load, but the present is now ahead of the voltage. The capacitors installed for the heap's intensity factor modification are the main sources of regular capacitive loads. The heap current is increasing because to the poor power factor. Previously, a separate power approach was used to address this technique, which involved manual capacitor replacement.

For the responsive power compensation using a microprocessor (89S52) with programmed control and capacitor exchange. Utilising an 89S52 microprocessor, the Automatic Power Factor Correction (APFC) device is constructed. Zero cross detector is used to convert the voltage and current sample into square wave. The microcontroller receives the samples at INT0 and INT1, and it computes the phase angle difference—the difference between the two waveforms. with the inbuilt timer's assistance. High precision is used to measure the difference. Phase angle, matching angle, and power factor are all calculated for these time values. The value is shown on the LCD. Step-by-step, the capacitor banks are exchanged.

1.1. HOW POWER FACTOR IS IMPROVED BY APFC UNIT

APFC panels are panels that monitor overall power consumption and help to improve in power factor maintenance. APFC panels increase the value of the power factor, which provides power to meet the needs of the equipment. This benefits businesses by reducing high electricity bills and sudden electricity penalties. Thus, it plays the most significant role in the effective functioning of the device. In many industries, the use of induction motors/other electrical loads lags behind power components where large amounts of energy are wasted. In the APFC panel a group of capacitor banks are installed. This cluster of capacitors has a unique purpose that is to provide reactive power to the inductive loads as per their requirement. It improves the power factor and increases the voltage depending on the capacitor bank size. Moreover, inductive loads consume all reactive power and capacity loads increase that reactive power. Such capacitor clusters increase the device power factor while improving the over all power factor of the bank. APFC panels increase the power factor by adding a capacitor Bank in parallel with the load. Moreover, it is very dangerous to manually switch on/off the capacitor when the load is fluctuating. Power factor correction capacitors increase the overall power factor value resulting in significant electrical energy savings. Further, the APFc panels are designed to monitor the adequate functioning of capacitors. Therefore, the use of HDFC balance to increase the power factor has become the most important rule in various enterprises.

1.2. What is APFC Unit

APFC is an automatic power factor correction unit used to increase the power factor by automatically switching on an of the capacitor bank units as required. The function of APFC panel is to improve the power factor. Most electrical loads are reactive, resulting in poor power factor. Electricity distribution companies encourage consumers to improve electricity efficiency. To improve power factor, power consumers have to add capacitors of optimum rating to inductive loads. The APFC panel has a microcontroller based programmable controller that automatically switches capacitor banks of suitable capacity between phases reactive load. VISA works on the principle of VAR sensing to maintain 0.99 lag power factor. In industries we have different types of loads like resistive, inductive and capacitive. A hard and fast capacitor or capacitor bank must be added to the left side of the transformer to improve the convience factor. Required for the approximate KVAr of the capacitor. APFC should be recommended if the installation contents various small loads with a mixture of heavy loads.

1.3. METHODOLOGY

Voltage and current unit: Current transformer (CT) connected in line and the potential transformer (PT) is connected parallel with the supply line.

Comparator unit: It takes the values of voltage and current from Power Transformer and Current Transformer respectively and gives the information to the microcontroller.

Microcontroller (89S52): The ATmega328 is manufactured by Atmel in the mega AVR family of microcontroller. It is used to perform various functions and independent works. It calculate the phase delay between current and voltage.

Transformer: Transformers converts AC supply from one voltage to another voltage with low loss of power. Transformers work only with AC supply.

Choke coil: A coil is a series of loops. A coiled coil is a design where the coil is also wound to itself. A coil is made of a material usually rigid, that can be formed into a spiral or helical shape.

1.4. BENEFITS OF POWER FACTOR CORRECTION:

Advantages that can be gain by applying power factor correction:-

- Environmental benefits- improved energy efficiency, reduces electricity consumption.
- Less electricity consumption means less greenhouse gas emission and less fossil fuel used by power plants.
- Reduction of electricity bills.
- Additional KVA available from existing supply.

1.5. FEATURES:

- Automatic Power Factor Correction.
- Easy to use, Self-explanatory kit.
- All-inclusive solution kit.
- Extensive audio-visuals available.
- Branding-free material.
- Pre-programmed Microcontroller.
- Call/mail for Tech Support from 10 am – 7 pm IST

2. Block Diagram

An 89S52 microcontroller is utilized in this undertaking as a focal preparing unit to figure the power factor and to switch the capacitors. It utilizes a potential transformer to supply the voltage to the Resistor divider organizes which recognizes the voltage wave structure. These voltage beats from the operational speaker are connected to the 8051 microcontroller as interfere with signs. So a transformer is utilized here to give the real time wave to the Resistor divider arranges. The operational amplifier is empowered for each 10 ms by contrasting the zero position of the current with the predefined setting. This flag is likewise connected to the 89S52 microcontroller as an interfere with flag. To address control factor, first we have to locate the present power factor. It can be finding by taking digression of proportion of time between zero intersection of current and voltage waveforms and two progressive zero intersection of voltage waveform. At that point it shows the determined power factor in the 20×4 LCD Display and switches ON the capacitors whenever required. The microcontroller discovers delay between these two obstructs and then it substitutes it in a specific condition for discovering the power factor. In the event that this power factor esteem is above 0.96, at that point the 8051 doesn’t send any order signs to the transfer driver to switch

the capacitors on. However, on the off chance that it is under 0.96, at that point the 89S52 sends order signs to the transfer driver so the capacitor bank on. At the point when load is associated the power factor is determined by the PIC microcontroller. If determined power factor is under 0.9, then the transfer switches on the capacitor. ULN2003 comprises of seven DARLINGTON PAIRS. The present lead in capacitor improves the relating current drop which is generally present in burdens. Thus the stage distinction between the current and voltage will be diminished. At the point when the resistive burden is on the power factor will be close to unity then the microcontroller doesn't enhance the transfer loop. At the point when the inductive burden is on the power factor decreases then the microcontroller energized the transfer loop so as to reimburse the intemperate receptive power. Due to the heap the power factor is revised. In this manner, these capacitors diminish the slacking idea of the heap by giving driving flows to it. As per power factor, the quantity of capacitors' exchanging relies.– exceptionally low power factor needs all the capacitor, while high power factor needs none of those.

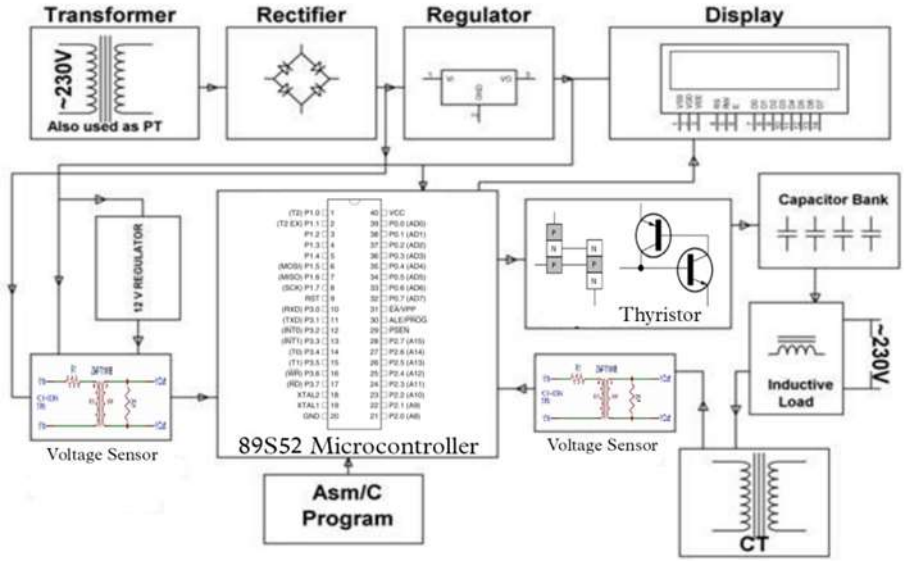

Fig. 1 – Block Diagram

Acknowledgements

Power factor correction using automatic power factor correction (APFC) units is important to increase the efficiency of electrical systems. APFC units dynamically correct the power factor by adjusting the reactive power to match the actual power demand of the system. This improvement reduces losses, improve voltage regulation and optimizes the use of electrical infrastructure. It helps to reduce electricity bills by reducing penalties associated with poor power factor and ensures efficient operation of equipment, there by increasing their lifespan. Overall, APFC units play an important role in enhancing the power quality and efficiency of electrical systems.

Conclusion

It can be concluded that Power factor improvement processes can be added to stabilize industries power systems and additional houses and does increase the stability efficiency of the framework system and increase the mechanical assembly. It dispenses with similar residential and small industrial units with penalties imposed due to low power factor for an individual period and techniques used to overcome power loss. Static capacitors are used in industries and distribution lines to improve power factor. Thus, it not only improve the power factor but also increases the line capacitance efficiency.

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