Automatic Power Factor Detection and Correction using 8051 Microcontroller

Mr. Shripad K. Ksheersagar[1], Gunwanti Sayare[2], Abhijeet Giripunje[3], Kiran Patle[4], Piyush Gajjalwar[5], Rohit Mane[6]

[1]Assistant Professor, Department of Electrical Engineering, Kavikulguru Institute of Technology & Science, Ramtek, Nagpur, Maharashtra, India-441106

[2]B.Tech. Scholar, Department of Electrical Engineering, Kavikulguru Institute of Technology & Science, Ramtek, Nagpur, Maharashtra, India-441106

[3]B.Tech. Scholar, Department of Electrical Engineering, Kavikulguru Institute of Technology & Science, Ramtek, Nagpur, Maharashtra, India-441106

[4]B.Tech. Scholar, Department of Electrical Engineering, Kavikulguru Institute of Technology & Science, Ramtek, Nagpur, Maharashtra, India-441106

[5]B.Tech. Scholar, Department of Electrical Engineering, Kavikulguru Institute of Technology & Science, Ramtek, Nagpur, Maharashtra, India-441106

[6]B.Tech. Scholar, Department of Electrical Engineering, Kavikulguru Institute of Technology & Science, Ramtek, Nagpur, Maharashtra, India-441106

ABSTRACT: In the present technological revolution, power is very precious. It is important to find out the causes of power loss and improve the stability of the power system. Due to industrialization, the use of inductive load has increased, and power systems have lost their efficiency. Hence need to improve the power factor with a suitable method. The project is designed to minimize the penalty using Automatic power factor regulators.
An automatic power factor detection and correction device reads the power factor from line voltage and line current by determining the delay in the arrival of the current signal with respect to the voltage signal from the AC mains. These time values are then calibrated as phase angle and corresponding power factor. Power factor correction is essential for improving electrical efficiency and reducing energy losses. This paper describes a real-time approach to measuring power factor, identifying lagging conditions, and dynamically switching capacitors to improve power factor. The MATLAB Simulink model is designed to simulate inductive load conditions and validate the correction mechanism.Automatic power factor detection and correction techniques can be applied to the IT industries, power systems, and also households to make them stable, and due to that the system becomes stable and hence increases the efficiency of the system.

KEYWORDS: Power Factor, Capacitor banks, Real-Time Monitoring, Energy Efficiency, Microcontroller.

1. INTRODUCTION

Power factor correction is a vital aspect of modern electrical systems, especially in applications involving inductive loads. Poor power factor can lead to increased energy costs, reduced system efficiency, and potential penalties from utility providers. The focus on the designing of a power factor detection and correction system utilizing the 8051 microcontroller. The integration of sensing devices and control algorithms facilitates precise detection of power factor deviations and adjusts reactive power accordingly. This approach not only enhances energy efficiency but also contributes to improved stability and reliability in electrical systems.

An Automatic Power Factor Detection and Correction System using the 8051 Microcontroller. The system continuously monitors the power factor of an electrical load, detects deviations from the ideal range, and automatically corrects it by switching capacitor banks to compensate for reactive power. The 8051 microcontroller plays a crucial role in processing power factor data, making real-time decisions, and controlling the capacitor switching mechanism and allowing for timely corrective actions. MATLAB-based simulation to analyze and improve power factor dynamically.The proposed system utilizes zero-crossing detectors to measure the phase difference between voltage and current waveforms, enabling precise power factor calculation. Based on the detected power factor value, improve system efficiency. The automation of power factor correction eliminates the need for manual intervention, enhances power system performance, and reduces electricity costs. In many industrial and commercial settings, the presence of inductive loads such as motors and transformers can lead to a significant reduction in power factor. Therefore, it is necessary to maintain the Power factor within a limit. This techniques can be applied to industries, power systems, and also to households to make them stable and also help in improving the efficiency of the system.

2. OBJECTIVES

This study approached to develop a Automatic Power Factor Detection and Correction System using the 8051 Microcontroller which has main following Objective:

1. Continuously monitor the power factor of the electrical system.
2. Reduce energy losses, lowering the electricity bills, and improving overall system performance.
3. Protect from low power factor Penalty.
4. Reduce energy Consumption

3. SIMULATION AND RESULT

3.1 Block Diagram and Result for Unity Power Factor

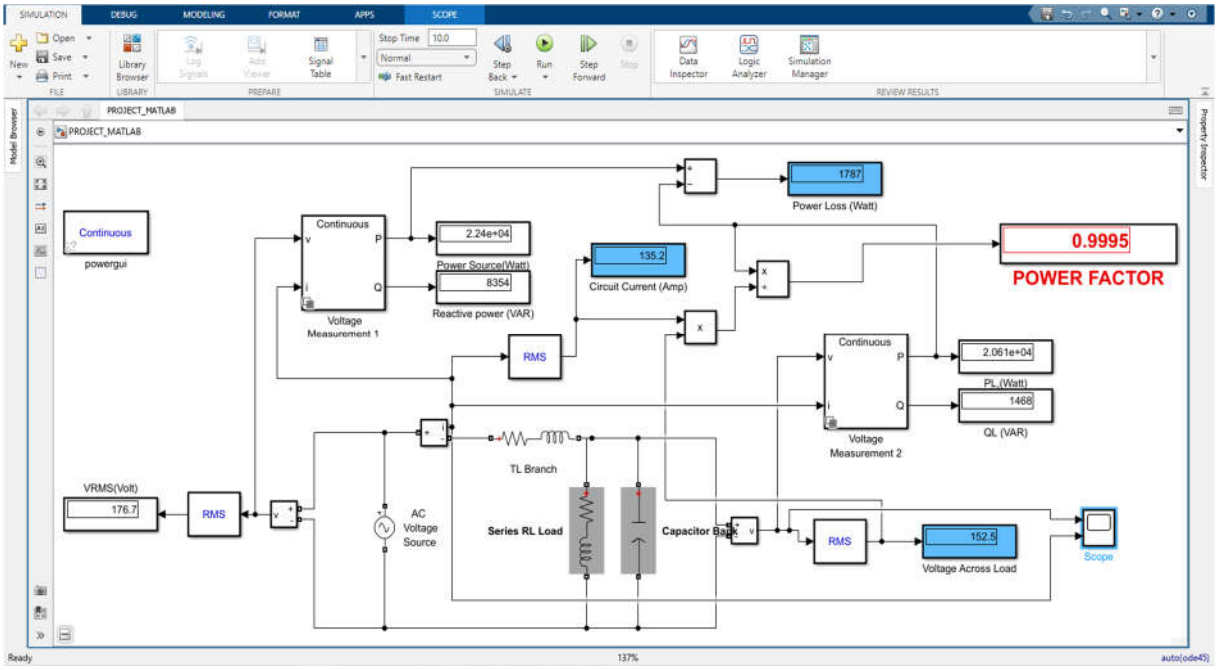

Fig 3.1(a) Simulation Circuit Diagram for Unity Power Factor

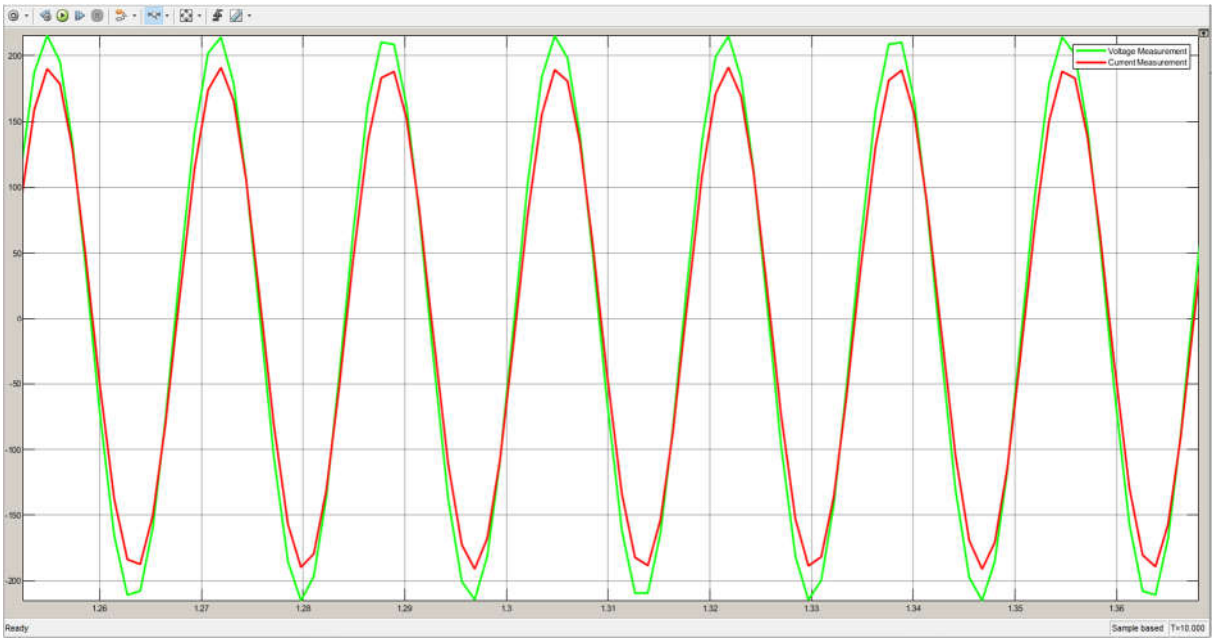

Fig 3.1(b) Simulation Output Waveform for Unity Power Factor

In the project module, **Fig3.1(a)** have Single phase AC 160V as input source, is used where capacitor bank is used for improving power factor of the system. As load module, we used a combination of resistive (R) & inductive (L) elements

In the above **Fig 3.1(b)** shows simulation output waveform for unity power factor where sinusoidal signal representing the AC voltage. "Red waveform" indicates the current waveform and "Green waveform" indicates the voltage waveform. Here voltage and current waveforms are in phase with each other. Therefore it is called as unity power factor. Unity power factor results in less current being drawn, therefore less electricity costs, less heat and greater longevity of the electrical system

3.2 Block Diagram and Result for Lagging Power Factor

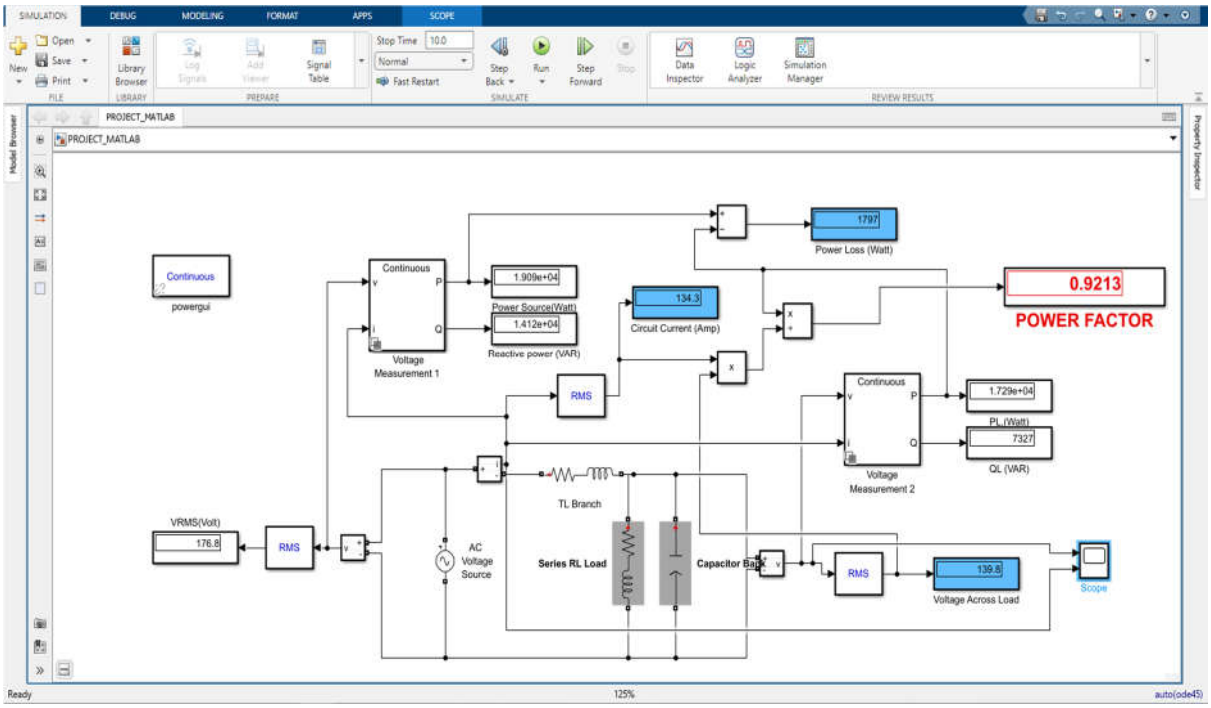

Fig 3.2(a) Simulation Circuit Diagram for Lagging Power Factor

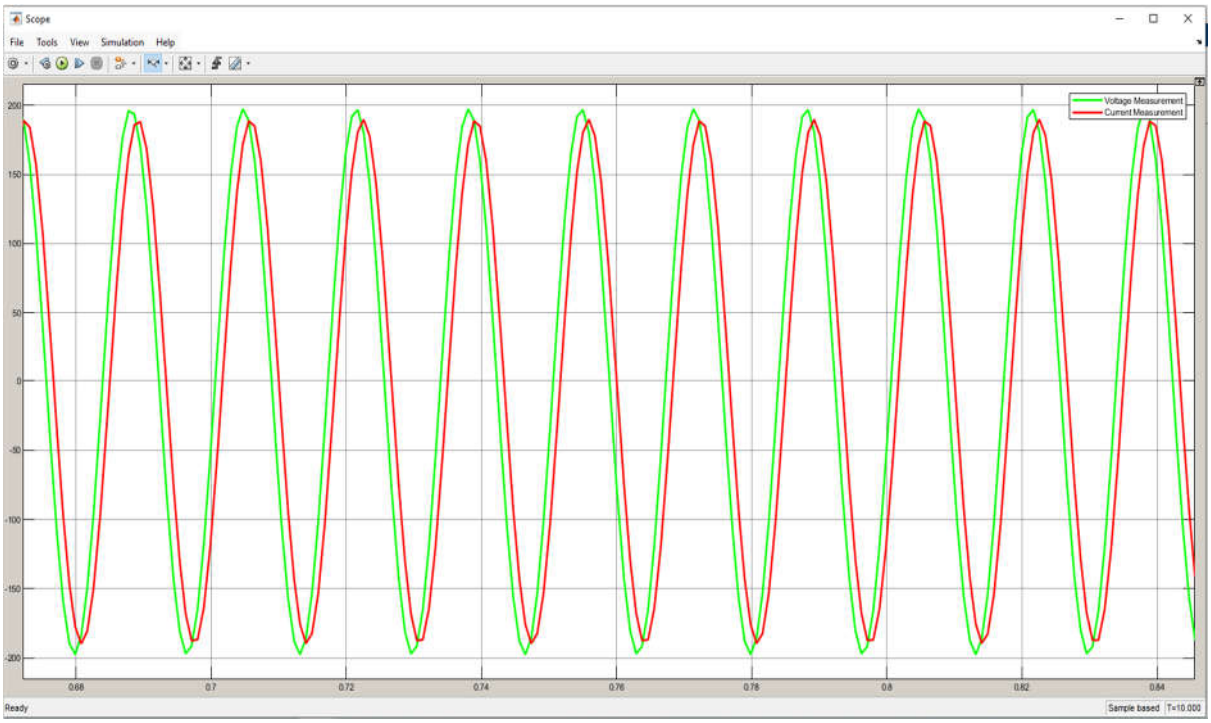

Fig 3.2(b) Simulation Output Waveform for Unity Power Factor

In the above **Fig 3.2(a)** shows the simulation circuit diagram for lagging power factor. In these case we are increasing the inductive and resistive load by keeping capacitive power constant. Therefore it results in poor power factor. Hence, there will be more current drawn, therefore more electricity costs, more heat generation and less life of the electrical system.
In the above **Fig 3.2(b)** shows the output waveform for lagging power factor where sinusoidal signal representing the AC voltage. "Red waveform" indicates the current waveform and "Green waveform" indicates the voltage waveform. The current waveform was lagging behind the voltage waveform, demonstrating the inductive nature of the load.

4. CONCLUSION

A load that uses alternating current needs apparent power, which is made up of both actual and reactive power. The power that the load actually uses is known as real power. Reactive power is the cyclical effect that happens when alternating current passes through a load containing a reactive component. Reactive power is repeatedly demanded by the load and given back to the power source.

When reactive power is present, the true power is always less than the perceived power, causing electrical loads to have a power factor below "1". The current flowing between the power source and the load is increased by reactive power, which also results in an increase in power losses along transmission and distribution lines. Power firms suffer operational and financial losses as a result. For avoiding all these problems we are implementing Automatic power factor correction equipment.

5. RESULT

We come to know that the power factor of the system is very essential part. Due to less power factor, it has been n noted various types of losses.

The capacitor load is used to maintain the power factor of system. Using MATLAB R2024b, a computer model for APFC system may be created.

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