

AUTOMATIC POWER FACTOR CORRECTION USING MICROCONTROLLER

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Abstract - In modern times the use of electricity is increasing day by day and most of the electrical energy utilized in industrial sector other than residential and farming sector. The conservation of electrical energy is of great importance because of the resources are decreasing as the time passes. In industrial sector most of the loads are of inductive in nature that is lagging type load. These lagging type of loads require reactive power which is to be provided by the power generating utility. But the loads are continuously varying so the need of reactive power varies. The poor power factor cause more losses in our power system. Also, poor power factor led to wastage of energy. The industrial and commercial installation in the country has large inductive loads installed which causes lagging power factor and gives penalties to consumers by utilities. So we need power factor correction which can compensate the reactive power requirement by the loads. For rapidly varying loads it is difficult to manually switch compensating capacitors. Automatic power factor correction unit which uses microcontroller compensate the reactive power by switching capacitor banks automatically and maintain power factor near to unity.

Key Words: Zero crossing detector, microcontroller, power factor, lagging load, Automatic correction, Capacitor bank.

1.INTRODUCTION

Power factor simply measures the electrical system efficiency. Mathematically, it is ratio of actual electric power dissipated by electric circuit to apparent load power. The inductive loads like three phase induction motors, various drives et c. require Reactive power to be generated and to maintain magnetic field in order to operate. Poor power factor leads to large demand of KVA, the high temperature due to increased losses, poor voltage regulation etc. Power factor improvement maximizes current carrying capacity and also improves voltage to equipment. The Correction capacitors generate reactive current. They help to compensate the non-working power used by inductive loads and hence power factor improved. High power factor is beneficial for both the customers and the power generating utilities. The transmission and distribution losses also

reduces when electricity is utilizes near to unity power factor.

2. PROPOSED SYSTEM MODEL

The microcontroller is the heart of the Automatic power factor correction unit. It processes the algorithms which are specified by the user to ensure the variation in the power factor in specifying limit and maintain power quality. The current transformer and voltage transformer are used to get the current and voltage signals which are inputs to the microcontroller.

This automatic power factor correction unit detects the phase lag between the voltage and current waveform by using zero crossing detector to determine the existing power factor. To bring it to unity, it is required to connect capacitor bank with the system. The number of capacitors that is to be connected for compensation is determined by the algorithms in microcontroller. When the power factor is not near to unity then the microcontroller sends the signal to switching unit which will switch the number of capacitors that is

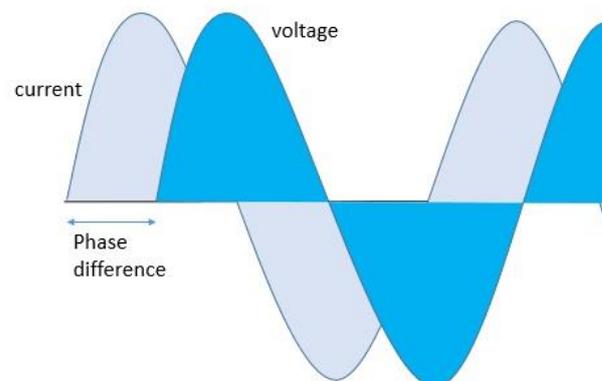
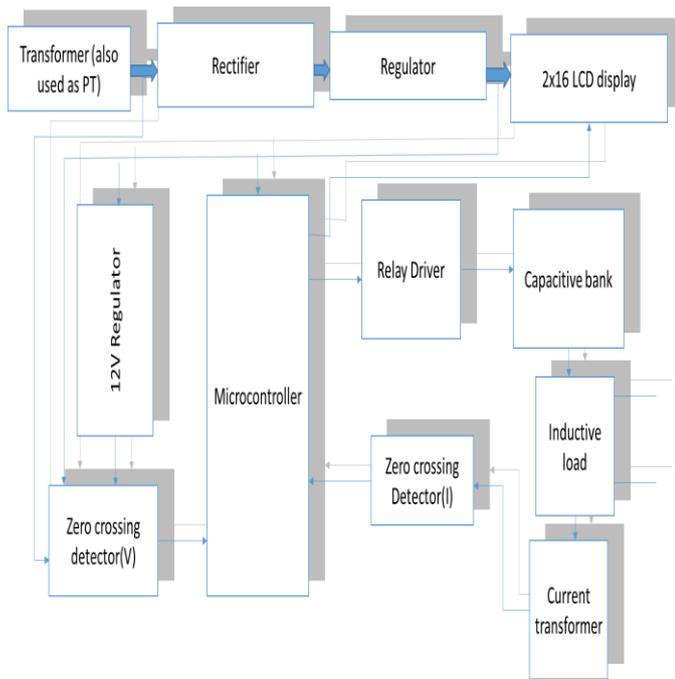


Fig 1. V-I Waveform

Demanded from the capacitor bank and connect it to the system with the help of relay. The relay driver is used for interface between the microcontroller and the capacitor banks. The LCD displays the existing power factor and also the result of compensation.

3. BLOCK DIAGRAM



4. DETERMINATION OF CAPACITOR SIZE:

Step 1: First of all, The kVA supplied by the utility and the power factor of the energy using equipment are measured. The previous bills also helps for this purpose

$$kVA_{ms} = kVA \text{ measured value.}$$

$$PF_{ms} = \text{measured value of power Factor.}$$

Step 2: Now Active Power is calculate using the measured kVA and power factor.

$$\text{Active power (KW)} = KVA_{ms} * PF_{ms}$$

Step 3: Now kVAR of the system is calculated.

$$kVAR_{sys} = [KVA_{ms}^2 - KW^2]^{1/2}$$

Step 4: The new power factor is identified that is to be achieved, say it target PF_{new}

Step 5: Using the targeted power factor calculate new kVA.

$$KVA_{new} = kW / PF_{new}$$

Step 6: Once the required power factor is achieved then calculate $kVAR_{new}$:

$$KVAR_{new} = [KVA_{new}^2 - KW^2]^{1/2}$$

Step 7: $kVAR_{new}$ is the difference between $kVAR_{sys}$ added capacitor's kVAR.

$$KVAR_{new} = kVAR_{sys} - KVAR_{cap}$$

Step 8: So kVAR of the capacitors to be installed is $kVAR_{cap} = kVAR_{sys} - kVAR_{new}$.

4. OPERATION

The step down of the current and voltage is required to be done to provide appropriate voltage level to the microcontroller with the help of voltage and current transformer. The lowered value is fed into the microcontroller for its operation.

Now, voltage and current signals are passed through the zero crossing detector which detects the zero crossing time of both the waveforms. The IC LM311 is used for this purpose. This is the second stage of the operation. The phase difference is the time difference of both the waveform when it crossed the zero level. Using this phase difference the microcontroller calculates the power factor. The next step refers to the automatic control unit with continuously monitors load and maintain the power quality of the system.

Case 1: In case of resistive load, there is no phase delay between current and voltage signals so they are in phase. The power factor in this case would be unity and no insertion of capacitors is required for improvement.

Case 2: When Inductive load is turned ON the phase delay between voltage and current signals is sensed by microcontroller. The power factor is calculated and the desired value of capacitor is inserted to improve the power factor of the system. Now after the insertion of the capacitors the current and voltage waveform is in phase and hence the power factor is improved.

5. CONCLUSIONS

The Automatic power factor correction unit is the cheapest way to implement the power factor compensation for the lagging loads which are continually varying. It brings the power factor near to unity. Also we can define the power factor range which should be maintained for a particular system using this unit. It also monitors the lagging and leading power factor and takes the necessary control action. The real time data for the power factor can also be stored using this unit. The consumers using power near unity power factor is also provided incentives to encourage the efficient use of electricity.

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