Automatic Power Factor Correction using the Capacitor Bank

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Abstract— Now a days problem of power factor correction is common to all the industrial companies. The aim of this automatic power factor correcting unit is to ensure the unity power factor in the system. All the hardware and software that is required to implement such type of apfc unit is explained in detail. Thus this apfc unit increase the efficiency via reducing the time taken for power factor correction.

Key words: Industries, Power Factor, Automatic, Efficiency, APFC

I. INTRODUCTION

Mainly the loads we use in industries are inductive in nature like computers, welding machines, arc furnaces ,electronic controls, induction motors ,ac/dc drives. There are less resistive load such as incandescent bulb & heaters. Capacitive loads like synchronous motors are rarely seen.[1] Thus if we see the net load is highly inductive which will cause a poor lagging power factor &if we will not correct the power factor then maximum demand requirement of electricity will increase as well as penalty for poor power factor. The general solution is to use capacitor to compensate the inductive load.

II. PROBLEM STATEMENT

generally we have to supply alternating current to operate the electrical load. Electrical load needs apparent power & this is the component of real &reactive power. Real power is the power which is actually consumed by the load ,for which we pay electricity bills. whereas the reactive power is the power which is repeatedly demanded by the load side and returned to the source ,means this power is nothing to deal with electricity biils but yes it has a very large impact on power factor and similarly on penalty.

If there is reactive power present in system it simply means that real power is less than the apparent power which reveals that system power factor is less than unity. if the power factor goes below the 0.95 then we have to pay the penalty.

P=TRUE POWER (IN WATTS)
$P=I^2R$
Q=REACTIVE POWER(VOLT AMP REACTIVE) $Q=I^2X$
S=APPARENT POWER (VOLT AMPS)
$S=I^2Z$

If there is increase in reactive power then there will be increase in current that will further increase the power losses. thus power companies have to face operational and financial losses. therefore power companies want every customers, specially with large inductive loads like industries to maintain their power factor above a specific limit (nearly 0.95) to ensure proper lossless supply. that is the reason why we are interested in power factor because it affect cost as well as efficiency.

If we look at another scenario ,here if reactive power is increased then it will increase the current in system which will lead to requirement of high current capacity wires ,switches ,transformers ,transmission lines, circuit breakers etc.

By power factor correction we are attempting to adjust the power factor up to unity. there are one simpler method is to switching in or out the capacitor bank.

Sometimes if we see there will be nonlinear loads for which harmonic components occur in ac current so simple method does not cancel out the reactive power at harmonic frequencies. so we have to use more suitable technique for the nonlinear loads.

III. BLOCK DIAGRAM

Here is the diagram of the automatic power factor control. here regulated power supply is used as a input. First we apply 230v ac supply then it is step down to 12v via transformer. Then it is fed to rectifier. This is the pulsating dc voltage. Then we have to apply filter in order to get the pure dc. Voltage and current waveforms are being taken from the potential and current transformer then via zero crossing detector we get square wave, these signals then fed to microcontroller where we calculate the phase difference then the power factor.

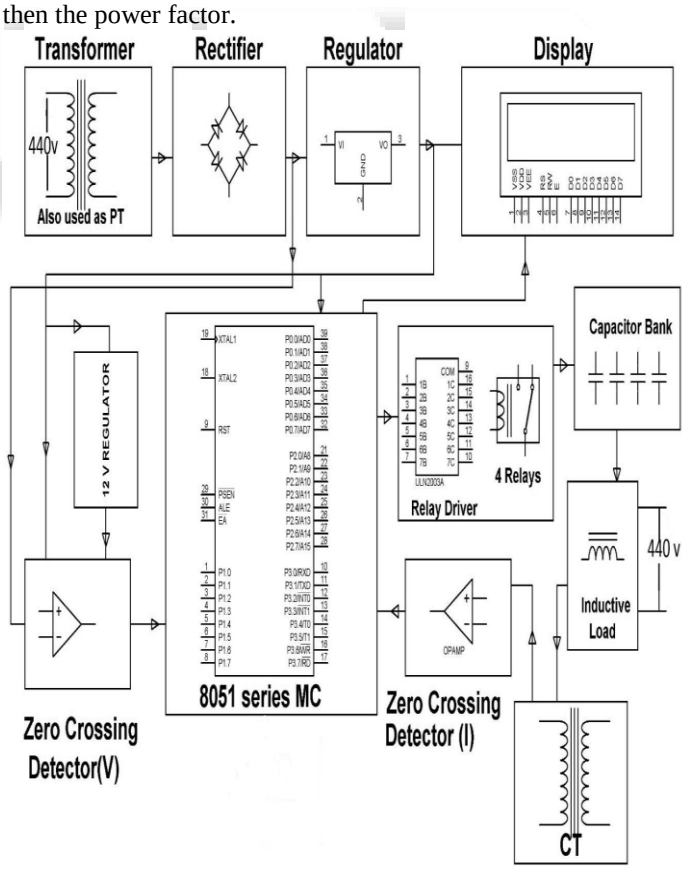

Fig. 1: block diagram of APFC unit

Here the microcontroller AT89S52 is the heart of the whole APFC unit. it takes input from the user and zero crossing of current ,voltage waveforms. It controls the bank of capacitor as required.

Status of power factor is shown on the LCD. If there is an error it will be corrected by the capacitor bank.

IV. SIMULATION AND OBSERVATIONS

Proteus VSM is used as a simulation tool for the analysis of the APFC unit. It is an interactive circuit simulation tool in the design field. By this It is possible to draw a complete circuitry for a micro-controller based system and then testing it interactively, all stuffs from within the single software. For the educational user and engineering field, ISIS also used for producing attractive schematics. APFC Simulation on Proteus VSM It shows input waveform of the voltage and the current with phase difference. Both of the waveforms i.e. v & I are fed to zero crossing detectors, which give square wave in digits format. Here is the flow chart of operation.

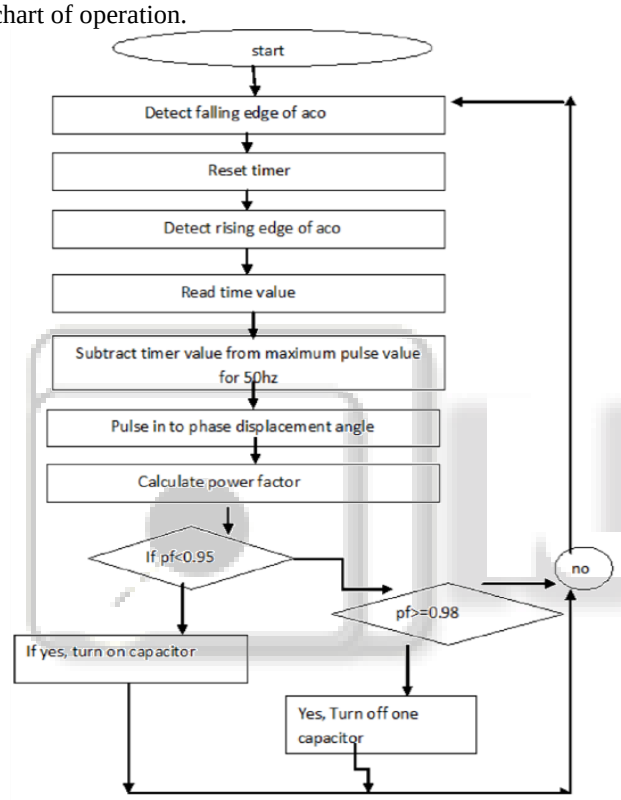

Fig. 2: flow chart of the operation

After operation we can conclude the following observations:td in millisec

Pulse gen. (A) Start time	Pulse gen. (B) Start time	td	Clock No.	PF	PORTC Output	Cap. connection serially
4ms	0	3	1749	0.58	High	On
2ms	0	2	1999	0.8	High	On
1.5ms	0	1.5	2124	0.89	High	On
1ms	0	1	2249	0.95	High	On
800µs	0	0.8	2299	0.96	NC	NC
600µs	0	0.6	2349	0.98	NC	NC
400µs	0	0.4	2399	0.99	Low	Off

Table 1.

V. RESULTS AND CONCLUSIONS

Here By observing all aspects regarding the power factor it is very clear that power factor is the important part for the utility company & also for the consumer. Utility companies get free from the power losses whereas the consumers are free from low power factor penalty charges. That is applied by electricity board.

By installing capacitor bank the Power Factor is improved and the value becomes nearer to the 0.9 to 0.95 thus minimizing the line losses and improving the efficiency of electrical power system. Thus by using APFC system the efficiency of the system is highly increased.

VI. FUTURE ENHANCEMENTS

Automatic correction of the power factor using the capacitive load banks is very efficient because it it is not only reduces the cost by decreasing the power drawn from the supply but also operates automatically, thus by this manpower are not required. thus this Automated Power factor Correction using capacitive load banks can be used for the industrial purpose in the future.

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