

Automatic Power Factor Control Panel

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Abstract—The Purpose of this paper is implementing a new technology for power factor improvement of 3 phase induction motor as well as for single phase induction motor, as improvement of power factor is necessary for industrial as well as domestic areas & to make power factor as close as unity without facing penalty from electrical distributors. As we know in industries most of motor which is usually used is induction motor and induction motor having low power factor also. Home appliances which are generally used are generally having low power factor. Hence there is need of power factor improvement in case of household appliances as well as in industrial purpose. Induction motor is most widely used motors in industries. As name of this motor specifies this motor having low power factor. Hence there is need of power factor improvement.

Keywords —A.C–Alternating current, P.F–power factor, P.F.C–power factor correction, Active power, Apparent power, Reactive power, Polynomial, Inductive load, Capacitive load.

I. INTRODUCTION

In any AC system the current, and thus the power, is formed of variety of components based on the nature of the load consuming the power. These are resistive, inductive and capacitive elements. In case of a purely resistive load, for instance, electrical resistance heating, incandescent lighting, etc., the current and also the voltage are in phase i.e the current follows the voltage. While, in case of inductive loads, current lags behind the voltage i.e the current is out of phase with the voltage. Almost all of the equipment and appliances in the present day are inductive in nature (Except few purely resistive loads and synchronous motors), for instance, inductive motors of every type, electric arc, welding machines, and induction furnaces, choke coils and magnetic systems, transformers and regulators, etc. In the case of a capacitive load the current and voltage are once more out of phase however now the current leads the voltage. The foremost common capacitive loads are the capacitors put in for the correction of power factor of the load.

II. PROBLEM STATEMENT

An electrical load that operates on alternating current requires apparent power, which consists of real power plus reactive power. Real power is the power actually consumed by the load. Reactive power is repeatedly demanded by the load and returned to the power source, and it is the cyclical effect that occurs when alternating current passes through a load that contains a reactive component. The presence of reactive power causes the real power to be less than the apparent power, and so, the electric load has a power factor of less than 1. The reactive power increases the current flowing between the power source and the load, which increases the power losses through transmission and distribution lines. This results in operational and financial losses for power companies. Therefore, power companies require their customers, especially those with large loads, to maintain their power factors above a specified amount (usually 0.90 or higher) or be subject to additional charges. Electrical engineers involved with the generation, transmission, distribution and consumption of electrical power have an interest in the power factor of loads because power factors affect efficiencies and costs for both the electrical power industry and the consumers. In addition to the increased operating costs, reactive power can require the use of wiring, switches, circuit breakers, transformers and transmission lines with higher current capacities. Power factor correction attempts to adjust the power factor of an AC load or an AC power transmission system to unity (1.00) through various methods. Simple methods include switching in or out banks of capacitors or inductors which act to cancel the inductive or capacitive effects of the load, respectively. Non-linear loads create harmonic currents in addition to the original AC current.

III. NEEDS OF POWER FACTOR CORRECTION

- Power factor correction (PFC) is a technique of counteracting the undesirable effects of electric loads that create a powerfactor that is less than one.
- Power factor correction may be applied either by an electrical power transmission utility to improve the stability and efficiency of the transmission network or correction may be installed by individual electrical customers to reduce the costscharged to them by their electricity supplier.
- An electrical load that operates on alternating current requires apparent power, which consists of real power plus reactive power. Real power is the power actually consumed by the load. Reactive power is repeatedly demanded by the load and returned to the power source, and it is the cyclical effect that occurs when alternating current passes through a load that contains a reactive component.
- Power factor correction attempts to adjust the power factor of an AC load or an AC power transmission system to unity through various methods. Simple methods include switching in or out banks of capacitors or inductors which act to cancel the inductive or capacitive effects of the load, respectively. For example, the inductive effect of motor loads may beoffset by locally connected capacitors.

IV. MAIN COMPONENTS

4.1 Controller

It is a brain of the Device which perform the all the logical operation and gives the initial command to perform the task. The controller as received by the user will either be mounted in a panel or supplied for mounting in a panel. In any case a panel is required for connecting the controller in the electrical system.

Specifications:

Voltage: 415V.

Current: 5A.

Number of steps operation: 4 step.

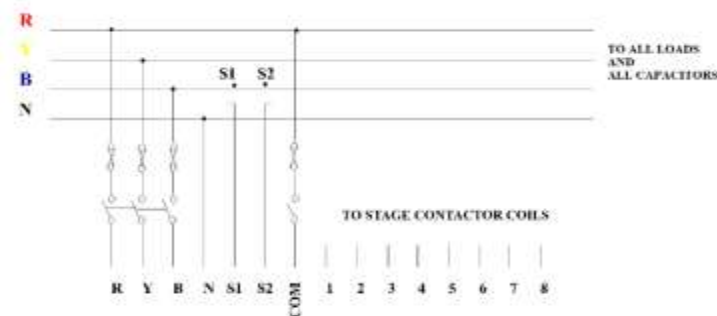


Fig.1 Main components

4.2 Contactor

It is basically a realy which is connected with the capacitor.it makes the on and off the capacitor. A contactor is an electrically-controlled switch used for switching an electrical power circuit.A contactor is typically controlled by a circuit, which has a much lower power level than the switched circuit, such as a 24-volt coil electromagnet controlling a 230-volt motor switch.

Specifications:

Voltage: 415V.

Current: 10A.

4.3 Current transformer

It is used to indicate the reading which sense to the controller to operate.

Current ratio: 20:5.

4.4 MCB

It is one type of operating switch which protects the device from the short circuit and overload. If the circuit exceeds the current rating of this device, the unit will trip protecting the induction motor.

Specifications:

Voltage: 415V.

Short circuit current capacity: 32A.

Pole: 4.

4.5 Capacitor bank

It is used to raise the power factor from lagging to leading and connected to contactor.

Specifications:

Voltage: 415V.

Over current withstand capacity: 1.3*In.

Quantity: 4nos(1KVAR)

V. SELECTION OF CAPACITOR

Consider a system have output power(Kw)=3.725Kw at 0.85 power factor.

Power factor=Active power/Apparant power.

$KVA = 3.725 / 0.85 = 4.38KVA$.

From the power form

$KVA^2 = KW^2 + KVAR^2$

$(4.38)^2 = (3.725)^2 + (kVAr)^2$

kVAr = 2.30 kVAr

Now power factor corrected from 0.85 to 0.95

$KVA = 3.725 / 0.95$

3.92kVA

$kVA^2 = KW^2 + kVAr^2$

$(3.92)^2 = (3.725)^2 + (kVAr)^2$

kVAr = 1.22KVAr

Difference between the power = 2.30-1.22

= **1.08 kVAr**

VI. CIRCUIT DIAGRAM

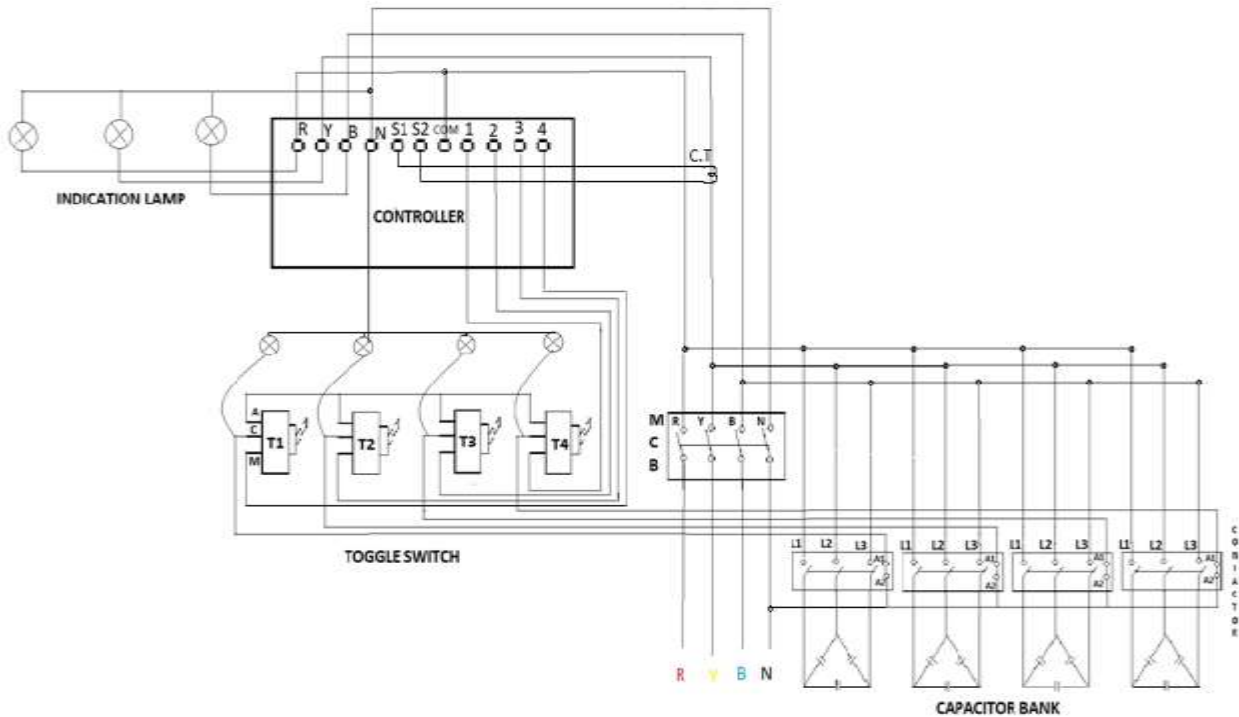


Fig.2 Circuit Diagram

VII. METHODOLOGY

- Two signals (voltage & current) are introduced in Controller from line by using Current transformer. When the load is inductive at that time power factor is quite low.
- Due to the low power factor current lags the voltage by the large angle.
- Controller calculates phase angle between this two signals by measuring time interval using timer. Controller calculates the power factor by formula (Cos X phase angle).
- Then it calculates the required compensation.
- Controller acts as the brain of the circuit it do all the mathematical operation.
- When the difference is detected then the controller close the contactors and contactors acts as switch between the capacitor and supply.
- Required capacitors are added in system to improve the power factor of the load.
- As capacitors are added, power factor gets increased up to the desired value.

- The improved Power factor is displayed on display of the controller panel.
- When the power factor is improved then the capacitor is disconnected from the load side and also remaining charged of the capacitor is discharged into the resistor.
- If the capacitor is not discharged then may be capacitor gets damaged and might be possible to person gets shocked.

VIII. CONCLUSION

This paper deals with advance method of power factor correction by using Controller. As Switching of capacitors are done automatically hence we get more accurate result, Power factor correction techniques makessystem stable and due to improvement in power factor its efficiency also increases. Power factor correction scheme canbe applied to industries, power systems as well as in household purpose. The use of microcontroller reduces the costs.By using microcontroller multiple parameters can becontrolled and the use of extra hard wares such as timer.

IX. FUTURE SCOPE

1. Better utilization of electrical machine.
2. Reduction of losses.
3. Decreased monthly energy cost.
4. Overloading is avoided.

REFERENCES

- [1]. Keith Harker (1998). "Power System Commissioning and Maintenance practice." London: Institution of Electrical Engineers.
- [2]. Barsoum, Nader (2007) "Programming of Controller for Power Factor Correction" IEEE Conference on Modeling & Simulation, Pages:19-25.
- [3]. en.wikipedia.org/wiki/Power_factor_correction.
- [4] Ramasamy Natarajan (2005). "Power System Capacitors." Boca Raton, FL: Taylor & Francis.
- [5] RakenduMandal; Sanjoy Kumar Basu; AsimKar; ShyamaPada Chowdhury (1994) "A Microcomputer – Based Power Factor Controller", IEEE Transactions on Industrial Electronics, Volume: 41, Issue: 3, Pages: 361– 371.
- [6] Nader Barsoum, "Programming of PIC micro-controller for power factor correction," Proceedings of IEEE Conference on Modeling & Simulation, pp. 19-25, 2007.
- [7]. Jones, L. D.; Blackwell, D. —Energy Saver Power Factor Controller for induction Motors IEEE (1983).
- [8]. RakenduMandalSanjoy Kumar Basu; AsimKar; ShyamaPada Chowdhury —A Microcomputer – Based Power Factor Controllerl, IEEE Transactions on Industrial Electronics (1994).