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Power Saving Device By using Capacitors Bank

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Abstract -*Efficient generation of power at present is crucial as wastage of power is a global concern. Power factor measures a system's power efficiency and is an important aspect in improving the quality of supply. In most power systems, a poor power factor resulting from an increasing use of inductive loads is often overlooked. A power factor correction unit would allow the system to restore its power factor close to unity for economical operation. The advantages of correcting power factor include reduced power system losses, increased load carrying capabilities, improved voltages and much more. The aim of this project is to build an Automatic Power Factor Correction (APFC) Unit, which is able to monitor the energy consumption of a system and automatically improve its power factor. An open source energy monitoring library was implemented in the design for accurate power calculation. The APFC device calculates the reactive power consumed by a system's inductive load and compensates the lagging power factor using capacitance from a capacitor bank.*

***Key Words*:Automatic Power Factor Correction1, Solar Dynamics2, Photovoltaic3, Space Based Solar Power4,Wireless Power Transmission5**

1. INTRODUCTION

Power factor is defined as the ratio between the KW (actual load power) and the KVA (apparent load power) drawn by an electrical load. It is simply a measure of how efficiently the load current is being converted into useful work output . The lower the power factor of a system, the less economically it operates.

All inductive loads require active power (KW) to perform the actual work, and reactive power (KVAR) to maintain the magnetic field. This reactive power is necessary for the equipment to operate, but imposes an undesirable burden on the supply, causing the current to be out of phase with the voltage(current lags the voltage).

Low power factor can also result when inactive motors operate at less than full load-such as surface grinder performing a light cut, a circular saw that is only spinning, an air compressor that is unloaded etc. Losses caused by poor power factor are due to the reactive current flowing in the system and can be eliminated using PFC . Power factor correction (PFC) is the process of compensating a lagging current by a leading current, through connecting capacitance to the supply. Capacitors contained in most power factor correction system draws current that leads voltage and produce a leading power factor.

Power factor correction (PFC) is the process of compensating a lagging current by a leading current, through connecting capacitance to the supply. Capacitors contained in most power factor correction system draws current that leads voltage and produces a leading power factor. A sufficient capacitance is connected so that power factor is adjusted as close to unity as possible. Theoretically, capacitors could provide 100% of the needed reactive power, however, practically, correcting power factor much nearer to unity may result in harmonic distortion. If capacitors are connected to a circuit that operates nominally at a lagging power factor, the extent to which the circuit lags will reduce proportionately. Power factor correction is applied to neutralize as much of the magnetizing current as possible and to reduce losses in the distribution system. It offers many benefits to the commercial electrical consumer, including reduced utility bills by eliminating charges on reactive power, reduced losses making extra KVA available from the existing supply. Thus, it improves energy efficiency.

2. Power Saver Device?

As we discussed in our previous post on Power Factor, there are 2 kinds of electricity loads: resistive (e.g. lights, water heaters, coil heaters, etc) and inductive loads (e.g. ceiling fans, pumps, air conditioners and refrigerators). For resistive load, the energy (or electricity) supplied by utility is mostly same as the electricity used by the appliance. But in case of inductive loads some energy is used up to create magnetic field that is not useful. And the formula for the same is:kVAh (energy supplied by utility) x P.F (Power Factor) = kWh (energy used by appliance)

A power saver device improves the power factor that results in lesser kVAh (energy supplied by utility) per kWh (energy used by appliance). It does so by reducing the electrical current drawn from the utility.

3. Existing Methods:

A. Synchronous Condenser

It is a synchronous motor that rotates under no load condition. Asynchronous motor shows capacitive behaviour while operating in over-excited mode. By controlling the field excitation power factor can be adjusted continuously. It provides step-less PF correction and not affected by system harmonics. But its installation and maintenance is costly

B. Static Capacitor Bank

Capacitors causes leading power factor as it shifts current ahead of the voltage. So to correct lagging power factor, it is a convenient method for which this method is practiced worldwide vastly. Though it has some limitations like the inability to absorb harmonics and doesn't provide step-less correction, it is a popular choice for PFC for its low cost of installation and maintenance [11].

C. Phase Advancer:

This is an A C exciter which is mainly used for improvement of power Factor of the induction motor. Phase advancers are used suitably when synchronous motor use is not admissible. Phase advancers are uneconomical for motors that are under 200HP

D. Others Methods

There are also some other complicated methods invented for PF correction which are not much popular for economical purpose and some methods are under research. Phase Advancer, Three-phase buck-boost PFC circuit and controlling method etc. are some other under research methods. Our developed system is based on power factor correction using capacitors as it is convenient for economic design. PF will be determined by the microcontroller and capacitors will be introduced in the system. Automatic switching of capacitor combination ensures the desired amount of PF correction and eliminates over-correction.

4. PROPOSED SYSTEM

4.1 Power

supply Most of time embedded system circuit uses 12 volts. 5-volt DC is used as its operating voltage. It's necessary to change the 230 Volt A C supply to the essential D C supply. Firstly 12 volts ac supply is obtained by using stepdown transformer by reducing the 230 Volt supply to 12 volts. In this project the potential transformer (PT) outputs can be used in its place rather than going for another different step-down transformer. By rectification process, the 12 Volts A C is converted in to a 12 Volts pulsating DC voltage. The pulsating D C is then sent to a capacitive filter for smoothening and a standard 12 Volt DC is obtained as a output.

4.2 Potential transformer

They convert A.C from one level to another voltage level along with some loss of power. The P T utilizes a step-down transformer to lessen hazardously higher voltage to a more secure lower voltage in any substation. Potential Transformer used in automatic power factor correction project stepsdown the supply voltage from 230 V to 12 V as needed by circuit to work. Potential Transformers output is usually used for measuring and also various monitoring purposes.

4.3 Current transformer

In an electrical circuit, currents is measured by using a C T.At point when current is exceptionally high to straightforwardly apply to measuring instruments, the C T creates a decreased current, that can be suitably connected with measuring and recording instruments. C T that are used in the circuit also protects the measuring instruments from an exceptionally higher voltage. C T are mostly used in metering devices. and also, in protective relays

4.4Capacitor Banks

Power saver devices are nothing but capacitor banks. Capacitor banks provide capacitive load which is opposite of inductive load. When put in parallel with inductive load (like ceiling fans, pumps, ACs, etc) they improve the power factor thus taking less energy (from utility) for the same appliance (or same amount of work). Capacitive load in parallel with inductive load makes the system resistive.

Fig.1.Automatic Power Factor Correction (APFC)

The solar power satellite was proposed (by Glaser) to solve future problems caused by activities of human beings on the global scale. The research areas of SPS are concerned with not only technology and engineering, but also big problems such as "large scale project", "global energy production" and "exploitation of extraterrestrial resources", as well as economic problems such as "large scale andlong-term investment' and "risk analysis". The earth environment, which will be related to SPS, is already a societal issue of global scale.

5. These devices are good in following situations:

1. When there is lot of inductive load in the system (lots of pumping, air conditioning, refrigeration and fans) and the utility bills in kVAh.
2. When the wiring is not good and lots of electricity is being lost as heat through the wiring. Lesser current because of power savers can help reduce heat loss through wiring.

Fig -2: capacitor bank.

6. Reason for low power factor:

Power Factor is defined as ratio of KW to KVA; it gets; power value when KW is small Compared to KVA. The main reason for this is the induction load as they supply KVAR or magnetizing current to machine in operation, which does no real work done. The magnitude of KVAR is depends on size and number of motors being operated at a Time.

a) Transformer
b) Induction Motors
c) High intensity discharge lamp
d) Induction generators

7.Can it help in your office or factory?

In some commercial and most industrial sectors billing happens in 2 ways:

1.The contracted load is in kVA (or demand based billing).
2. The billing happens in kVAh units.
3. There are power factor penalties/rebates.

If billing is in kVAh, then by using power saver devices the kVAh consumption is less and the number of units that show up on electricity bill will be less.

If billing is in kVA (or demand based billing), you will reduce your maximum demand by putting power saver devices and thus save on fixed costs.

If there are power factor penalties then you save by improving the power factor of your premise and in fact can gain with better power factor rebates.

In case none of the above 3 conditions apply in your case, and then you will not save much by using a power saver device.

8. Advantages of Power factor improvement and Correction:

1. Increase in efficiency of system and devices
2. Low Voltage Drop
3. Reduction in size of a conductor and cable which reduces cost of the Cooper
4. An Increase in available power
5. Line Losses (Copper Losses) I2R is reduced
6. Appropriate Size of Electrical Machines (Transformer, Generators etc)
7. Eliminate the penalty of low power factor from the Electric Supply Company
8. Low kWh (Kilo Watt per hour)
9. Saving in the power bill
10. Better usage of power system, lines and generators etc
11. Saving in energy as well as rating and the cost of the electrical devices and equipment is reduced

9. CONCLUSION

The increasing global energy demand is likely to continue for many decades. New power plants of all sizes will be built. Fossils fuels will run off in another 3-4 decades. However energy independence is something only Space based solar power can deliver.Space based solar power (SBSP) concept is attractive because it is much more advantageous than ground based solar power. One of the most critical technologies for the SPS is microwave power transmission from the geosynchronous orbit to the ground. Evolutionary microwave technologies are required for high power conversion efficiency more than 80 % from to DC and an extremely high-precise beam control with 10 μrad accuracy.

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