Effective Energy Consumption with Power Quality Improvement in Distribution

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Abstract— Power quality improvement for nonlinear loads is the point of interest for researches in recent years. Power factor plays an effective role in efficiency of electrical system. In power system the voltage level at different system changes with the change in load. The voltage level at the load must be maintained within required range irrespective of the type & magnitude of the load. For maintaining voltage fixed within limits, it is necessary to maintain the balance of reactive power in the system as reactive power is related with voltage directly. The appropriate choice for such problem is static Var compensators (SVCs) due to its low cost and simple control strategy. This paper proposes to minimize the harmonics and increase the power quality into the power distribution systems by the operation of SVC used in coordination with fast changing loads. We present a design and performance of TRIAC based capacitor bank switching using Arduino Uno. The performance of system is evaluated for different load conditions.

Key words: Power Quality, Power Factor, Capacitor Bank, Arduino Uno Platform, SVC

I. INTRODUCTION

The Indian power distribution system encounters various problem due to large number of nonlinear loads. The poor voltage, poor factor presence of harmonics in the system are the major concerns of the utility grid. Which causes the increase in demand of electrical power most of the loads connected to the electrical system is inductive load which causes the lagging power factor. It makes the system less efficient. For the improvement of efficiency of the system, power factor quality is one of the basic requirements. Inductive load resulting in very low power factors. Electricity is not any more a luxury article like few decades ago, but it has become a necessity and a part of our everyday life. Even short interruptions and voltage sags can be harmful when the number of computers, programmable logics etc. in industry and as well in households have increased rapidly. In modern information society requirements and expectations associated with power quality have become increasingly important. Reasons for that are increased requirements for power quality by network utilities, customers and regulators. Many industrial and commercial customers have equipment that is sensitive to power disturbances. Therefore, it is more important to understand the quality of power being supplied in a power system, faults, dynamic operations, or nonlinear loads often cause various kinds of power quality disturbances such as voltage sags, voltage swells, switching transients, impulses, notches, flickers, harmonics, etc. One critical aspect of power quality studies is the ability to perform automatic power quality monitoring and data analysis

Inductive loads resulting in very low power factor. Thus, there exists a great necessity to closely match reactive power with the load so as to improve power factor, boost voltage reduces the losses. In this system, a more reliable, technically sound, fast acting and low-cost scheme is presented by arranging the thyristor switched capacitor units in binary sequential steps. The following expected outcomes are achieved by using Arduino control the signal to static VAR compensator (SVC) which fulfill the requirement of reactive power factor for a 1 phase, 50 HZ

- To maintaining the power factor at unity.
- To maintaining minimum feeder current
- To save the monthly bill on power factor and result in maximum demand charges.
- To compensate the reactive power from using SVC
- To maintain a balance load
- To reduce the unit cost by lead power factor

II. SYSTEM BLOCK DIAGRAM

The block diagram describes that the Arduino Uno base automatic controlling of power quality improvement using SVC

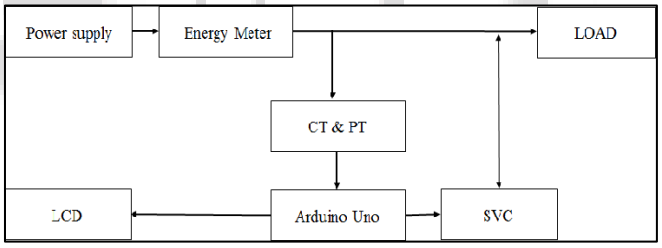

Fig. 1: Block diagram of power quality using SVC

The block diagram describes the single phase AC supply is given to energy meter. Energy meter is used to measure the power consumed by the load. Then the current transformer is connected and is used to measure the power factor whatever it is leading or lagging and the measure value is given the ardunio uno. Potential transformer is connected to load and the data is given to ardunio controller. The ardunio is programmed,if the voltage and power factor is more or less then the signal will given to the static Var compensator. If the power factor is lagging then static Var compensator will added the capacitor bank to making unity. If voltage less then static Var compensator will boost the voltage with 5 to 10 voltts. The power factor is displayed in the LCD display. LCD display has reset button and it is programmed ardunio which indicate the particular month usage of power.

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III. HARDWERE DESIGN

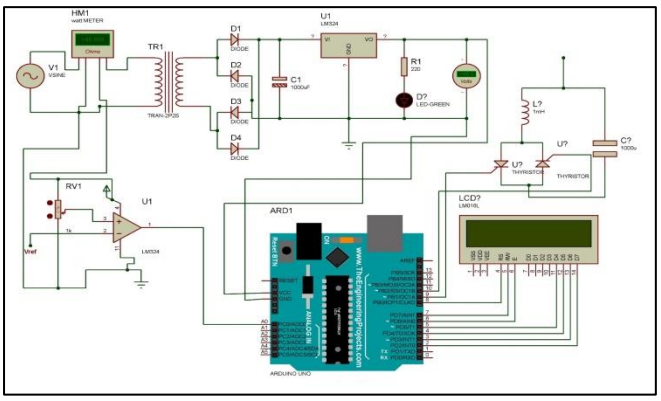

Fig. 2: Power quality improvement using by Static Var Compensator

IV. SYSTEM HARDWARE COMPONENTS

A. Static Var Compensator

A static VAR compensator is a parallel combination of controlled reactor and fixed shunt capacitor shown in the figure below. The thyristor switch assembly in the SVC controls the reactor. The firing angle of the thyristor controls the voltage across the inductor and thus the current flowing through the inductor. In this way, the reactive power draw by the inductor can be controlled.

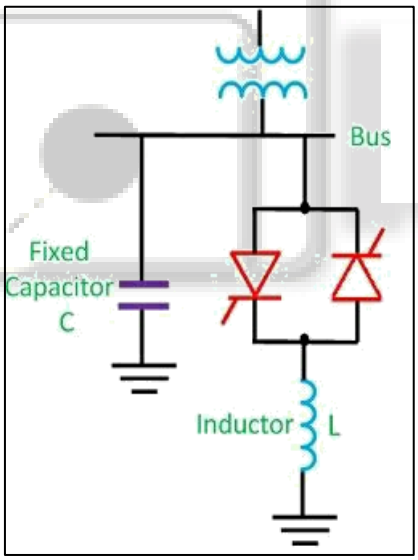

Fig. 3: Static Var Compensator

We are using static var compensator is improving the power quality and also it controlled the steady state and temporary over voltage. In sometimes we use of inductive load at the time power factor will become low in the causes of electricity bill become high. In our proposed method used in capacitor bank it improves the load power factor and therefore reduced line losses and improved system capability. Static VAR compensator has no rotating parts and is employed for surge impedance compensation and compensation by sectionalizing a long transmission line. It improved the transient stability of the system. In electric power transmission and distribution, volt-ampere reactive (var) is a unit by which reactive power is expressed in an AC electric power system. Reactive power exists in an AC circuit when the current and voltage are not in phase

B. Operation of SVC

Operation of SVC the Static Var Compensator (SVC) is composed of the capacitor banks/filter banks and air co reactors connected in parallel. The air core reactors are series connected to thyristors. The current of air-core reactors can be controlled by adjusting the fire angle of thyristors. The SVC can be considered as a dynamic reactive power source. It can supply capacitive reactive power to the grid or consume the spare inductive reactive power from the grid. Normally, the system can receive the reactive power from a capacitor bank, and the spare part can be consumed by an air-core shunt reactor. As mentioned, the current in the air-core reactor is controlled by a thyristor valve. The valve controls the fundamental current by changing the fire angle, ensuring the voltage can be limited to an acceptable range at the injected node (for power system var compensation), or the sum of reactive power at the injected node is zero which means the power factor is equal to 1 (for load var compensation). Current harmonics are inevitable during the operation of thyristor-controlled rectifiers. thus it is essential to have filters in a SVC system to eliminate the harmonics. The filter banks can not only absorb the risk harmonics, but also produce the capacitive reactive power. The SVC uses close loop control system to regulate bus bar voltage, reactive power exchange, power factor and three phase voltage balance.

C. Modelling of Static Var Compensator

The Static Var Compensator (SVC) is a shunt connected device whose main functionality is to regulate the voltage at a chosen bus by suitable control of its equivalent reactance. A basic topology consists of a series capacitor bank, C, in parallel with a thyristor-controlled reactor, L. In practice the SVC can be seen as an adjustable reactance that can perform both inductive and capacitive compensation.

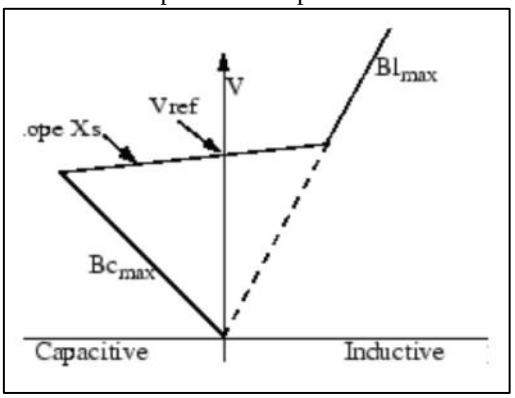

Fig. 4: SVC characteristics

The SVC voltage regulator processes the measured system variables and generates an output signal that is proportional to the desired reactive-power compensation. Different control variables and transfer functions of the voltage regulator are used, depending on the specific SVC application. The measured control variables are compared with a reference signal, usually Vref, and an error signal is input to PI controller. The output of the controller is a per-unit susceptance signal Bref, which is generated to reduce the error signal to zero in the steady state. The susceptance signal is subsequently transmitted to the gate pulse–generation circuit.

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V. SIMULATION RESULTS

SVC is simulated in MATLAB/SIMULINK software and connects to the power supply. In this system SVC is applied for power factor correction in system and also improves the power quality. Power quality improvement by using capacitor bank which is connected to the parallel of the system block. Simulation is done by the voltage and current relationship and also power factor including fault and no svc. Firstly, system is simulated not including load fault and SVC

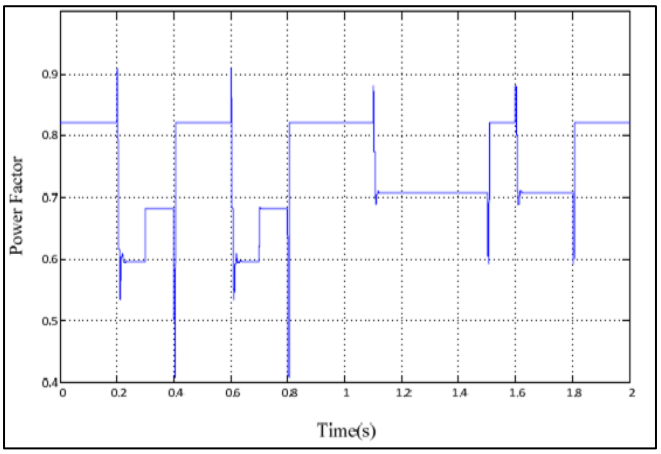

Fig 5. Power factor including fault load, no SVC

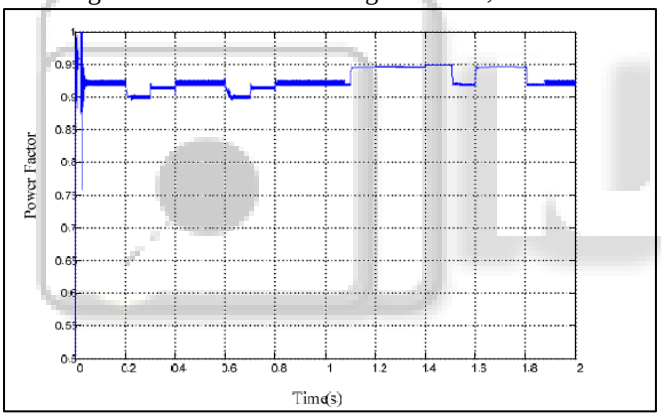

Fig. 6: Power factor including fault load and SVC

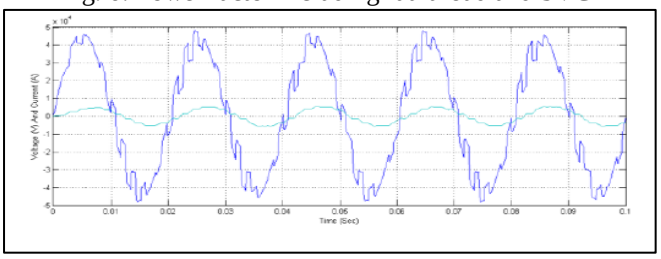

Fig. 7: Voltage and current of the system

The capacitor bank used to the increasing the voltage level and also maintained the power factor level the simulation diagram shown in figure 7.

VI. CONCLUSION

Today's changing electrical power system create a growing need for flexibility, reliability, fast response and accuracy in the fields of electrical power generation, transmission distribution and consumption. Power factor improvement is most desirable for an efficient electrical power system. Svc is one of the best, cost effective and promising solution for available for reactive power compensation and improve the power factor. Result and simulation of our proposed method increase the power quality and also maintained the power factor the main advantage of the maintain the power factor electricity bill become low and also system life time will be increase

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