Switching TSC/SCR Device to Control Reactive Power

Reactive power compensation

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Abstract — *FACTs devices are used for achieving high feasibility and tolerance of load variations for compensation of reactive power. By controlling the reactive power that is generated from transmission line system for different loading condition, therefore power factor of transmission line will improve.*

Keywords- *FACTs devices, series compensator, shunt compensator, Thyristor Switched Capacitor (TSC) device, Silicon controlled rectifier (SCR*

I. INTRODUCTION

Now a days there is increase in the demand at consumer site of electricity. In order to compute this problem more transmission lines are needed for power transmission, which is not possible economically as it will increase labour cost as well as losses due to transmission line. Compensation of reactive power of power system by FACT components are essential to eliminate this problem.

II. LITREATURE REVIEW

For safe operation of electrical appliances there should not be any phase difference between voltage and current of the transmission line and if there is phase difference there is chances of voltage fluctuations which will damage the equipment and increased the losses in transmission line that decrease is efficiency etc.

In a transmission line due to the fault or any other type of disturbance there is phase difference between voltage and current of the line for minimum phase difference the transmission line should be the only resistive purely resistive which is not possible as there are effects of capacitance and inductance in it and accordingly there is lead and lag nature in the phase so in order to compensate the leading and lagging effects there are many different methods used that is (i) series compensator (ii) Shunt compensator (iii) combined series shunt compensator.

Various compensating devices are capacitors, capacitors and inductors that is active compensator, while synchronous generator passive compensators. Shunt compensators cannot be distributed uniformly along the line. This is connected at the end of the line at/or at the end of the line.

The purpose in series compensation is to cancel part of series inductive reactance of the line using series capacitors that will help to increase in maximum power that is to be transferred, reduce the power angle for a given amount of power transfer, practically it is not desirable to exceed series compensation beyond 80% if the line is 100% compensated as it will behave as a purely resistive element.

FACTs devices can be effectively used for a power flow control, load sharing, voltage regulation, additional flexibility. In general AC controllers can be divided into 4 categories (i) series (ii) shunt (iii) combined series-series (iv) combined series-shunt controllers. The series controller could be variable impedance, such as capacitor, reactor etc. All series controllers inject voltage in series to the line. The shunt controllers have variable impedance, variable source or a combination of these.

Combined series-series controllers could be a combination of separate series controller which are controlled in a coordinated manner or in unified manner. Combined series-shunt controllers in a coordinated manner or a unified power flow controller with series and shunt elements. For unified controllers, there can be a real power exchange between the series and shunt controllers through a DC power link.

Shunt compensators (i) Static Var Compensator (SVC) (ii) Static Synchronous Compensator (STATCOM)
Series compensator (i) Thyristor Controlled Series Compensator (ii) Static Synchronous Series Compensator (SSSC)
Combined Series-Shunt compensator (i) Unified Power Flow Compensator (UPFC)

Thyristor-switched capacitor (TSC) it is shunt connected Thyristor-switched capacitor whose effective reactance is varied in a step wise manner by full-or zero-conduction operation of the Thyristor value. It consists of only a distance which capacitor bank which is split into number of units of equal ratings. [1]

There are 3 terminals in the SCR anode cathode and gate terminals, 4 layers of alternate p-type and n-type silicon semiconductor with 3 junctions. With functioning of gate pulses there are 3 modes revere blocking mode, forward blocking mode and forward conduction mode in which the Thyristor works [2]

There can be series and parallel combination of SCR. Series combination of SCR will fulfill our high voltage demand and parallel combination will fulfill our high current demand.

III. RESEARCH METHODOLOGY

Before implementing this idea in substation we have done it in small scale. Firstly we have simulated this in PROTEUS [3] software by building different circuits using ATMEGA 16 micro-controller. For this we have programmed program in BASCOM [4] software. There are 2 pulses one for voltage and other for current, program will the compare both the pulses and find out the phase difference between them, comparing process idea done by ATMEGA16 micro-controller and will give the commend to firing circuit of TRIAC. If there leading phase difference than inductor will switch-on, vice-versa.

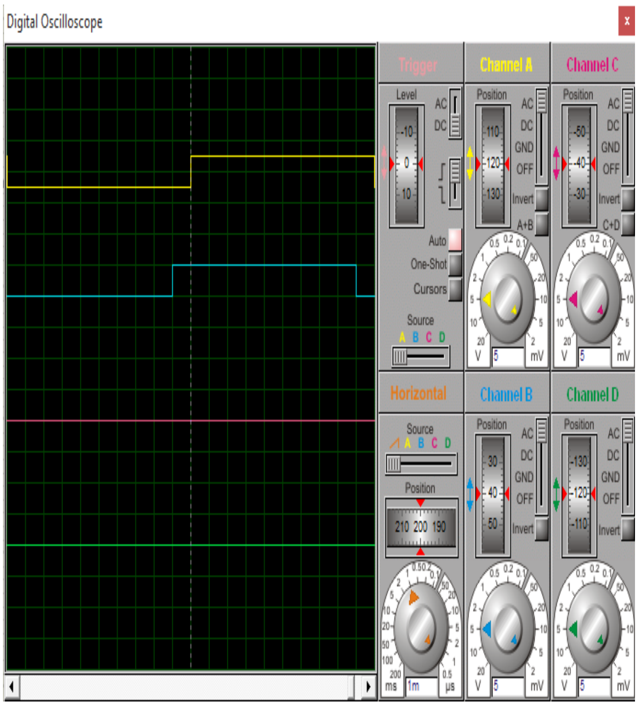

Figure (1): leading of current from voltage

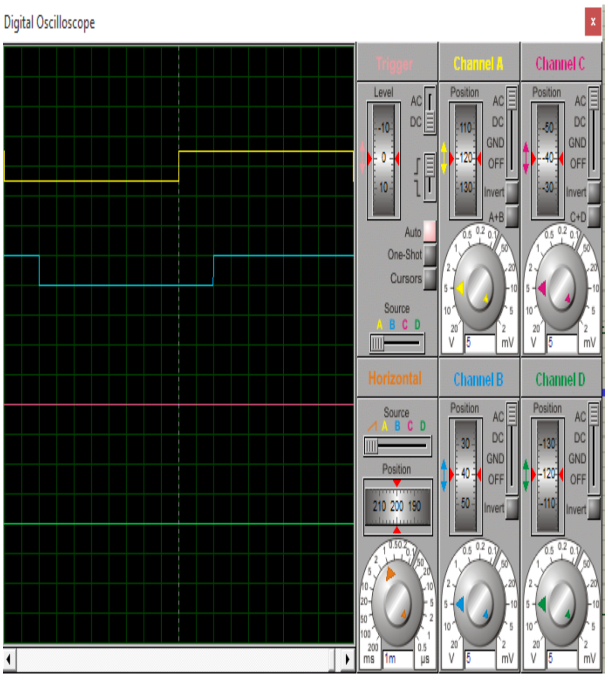

Figure (2): lagging of current from voltage

Figure (1) & (2) are the wave-forms taken in PROTEUS software of leading and lagging of current respectively.

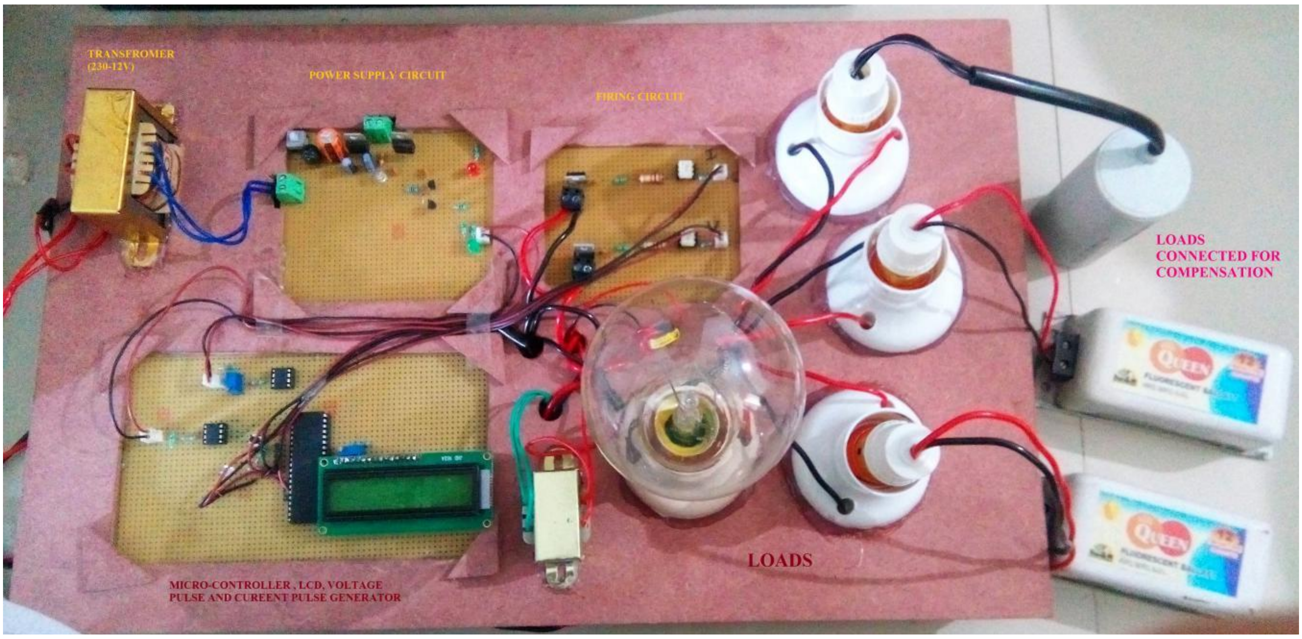

Fig.(3) Image of hardware

Above fig.(3) is the image of our hardware which we have implemented in small scale. First we have build power supply circuit to get 5V DC without any fluctuation. This 5V DC is given to micro-controller circuit (micro-controller and LCD for display). Here we have taken TRIAC for switching inductive or capacitive load at instant of time, to fire TRIAC we build firing circuit. Here, as inductive load fluorescent Ballast and as capacitive load capacitor is taken for compensation process.

We give 12V AC to power supply circuit via transformer (230-12V), by means of rectifier and voltage regulator ICs we get pure 5V DC, which is given to micro-controller as well as LCD. Program is loaded in micro-controller, as voltage square pulses and current square pulses given to it via voltage square circuit and current square circuit respectively. These pulses will be compared by micro-controller, if current waves are leading as compared to voltage at a instant of time command will be given to firing circuit and TRIAC will trigger and inductive load will connect for compensation. Same as if current wave will lag capacitive load for compensation. Thus this cycle will repeat till phase angle become 0 degree of current and voltage pulses.

Fig.(4) show the algorithm/flow diagram of our project. As shown in this flow diagram, we have to set parameters according to components used in it, as we have chosen ATMEGA16 micro-controller, it will compare the current and voltage pulses and give command to firing circuit. After this firing process of TRIAC capacitive or inductive load will connect for compensation

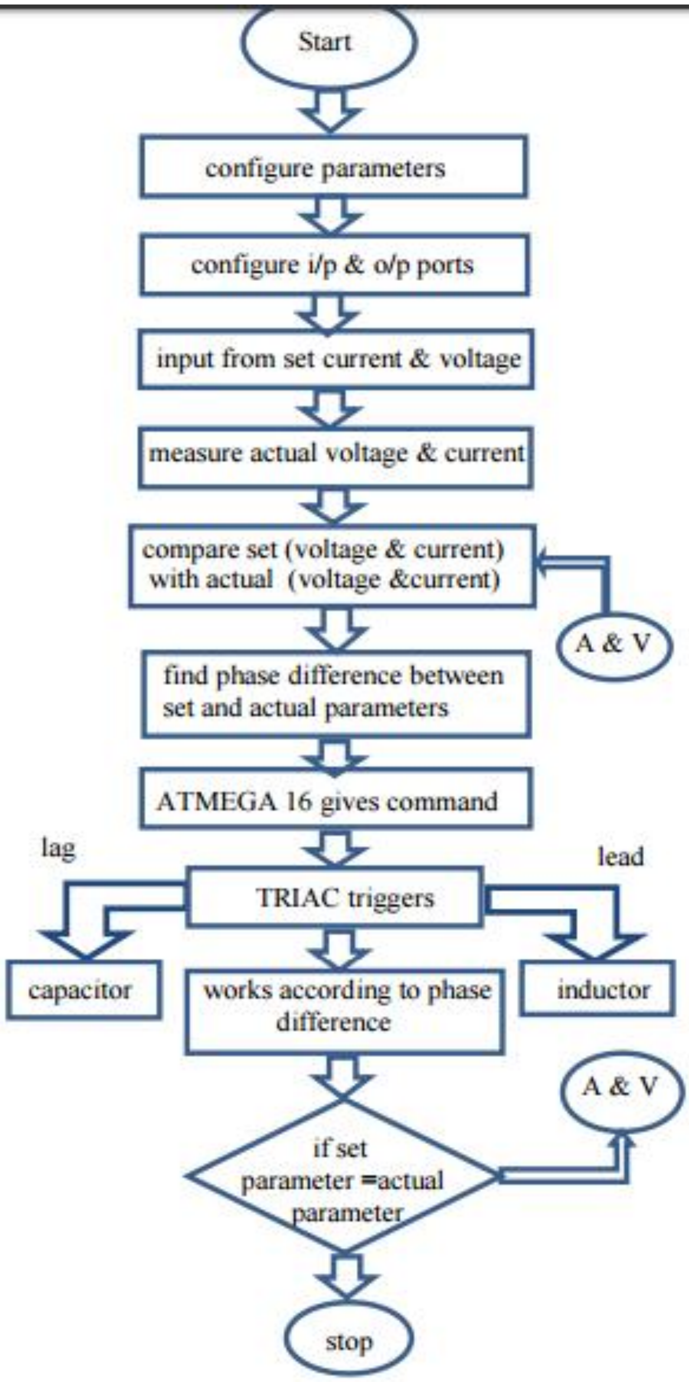

Fig. (4) Algorithm of compensation process

IV. RESULTS

As phase difference between current and voltage square pulses will sensed by the micro-controller, immediately command will be given to firing circuit to switch on the inductor if current is leading and vice-versa. Figure (4) shows the resultant wave forms of current and voltage, which are compensated and it shows 0 degree phase difference.

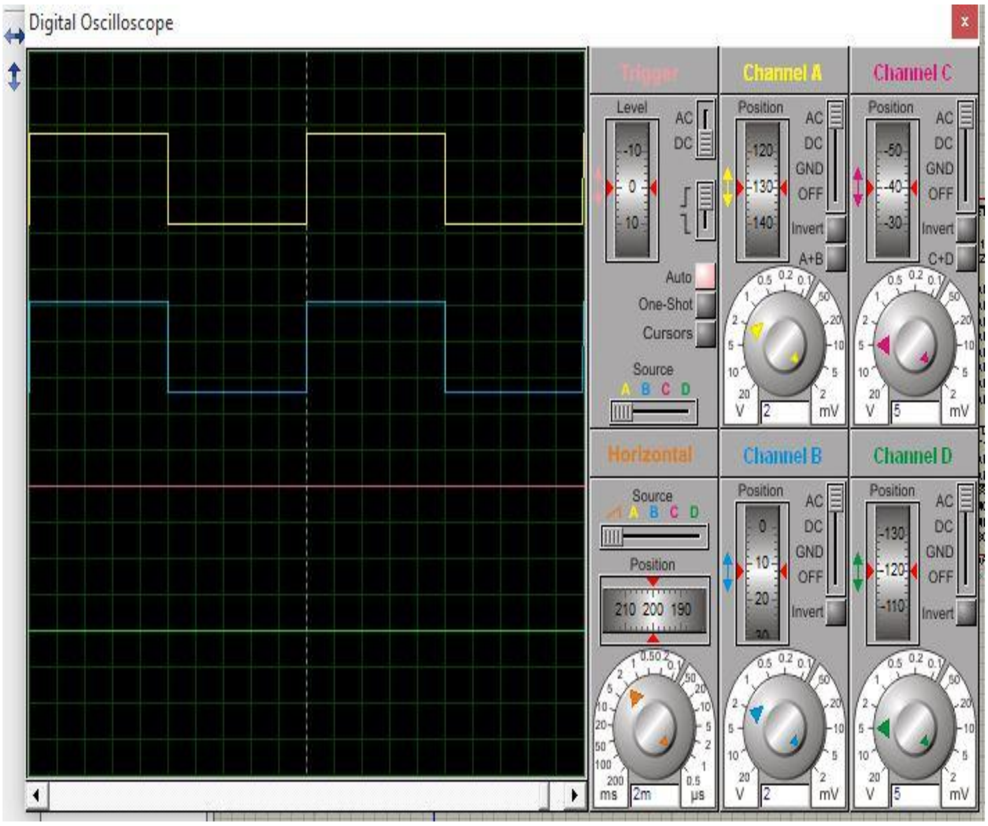

Figure (4): wave-forms of current and voltage after compensation

V. CONCLUSION

We conclude that, after comparing voltage square wave and current square wave, according to lag and lead of current square wave with respect to voltage square wave TRAIC will switch to capacitive or inductive load respectively thus reactive power is compensated by switching of TRIAC.

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