Hardware Implementation of Reactive Power Management Using Arm Controller

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Abstract- Most of transmission line losses are due to excess use of reactive power in circuit network, which puts extra burden on transmission lines as well as consume the capacity of transmission line.
In this review, an innovative transient free adaptive static VAR compensator design is studied and developed. An ARM controller is used to carry out process development which helps in automatic reactive (VAR) power compensation in addition to power factor correction. The static voltage compensation (SVC) needs to use capacitor bank in many series and parallel combination.

Keywords: Reactive Power, Capacitor Banks, VAR Compensation, Power factor, ARM Controller

I. INTRODUCTION

In rustic power dispersion framework we are utilizing more inductive load in farming range. Ideally when current and voltage are in stage at that point power factor is solidarity and circuit is resistive in nature around then. At the point when load is inductive in nature then voltage and current are driving then we utilized SVC for reactive power compensation and hence some power factor adjustment also possible [1], [4] and [6]. CT and PT helps in measuring current and voltage as well as they support to scale down the quantities required in developed circuit.

The precision rectifier will convert AC signal into pulsating DC form. The ARM microcontroller requires pure DC output. Low pass filter is used to avoid pulsating DC. Purified DC output is interfaced with ARM controller through ADC and stores in internal storage memory. An algorithm is developed and used for static voltage compensator.

A static VAR compensator comprises of capacitor bank in five parallel consecutive strides with thyristor controlled reactor [3]. The exchanging operations accomplished are sans transient and versatile. In power system analysis, there are three important studies that are essential for the entire operation of Power System Network.
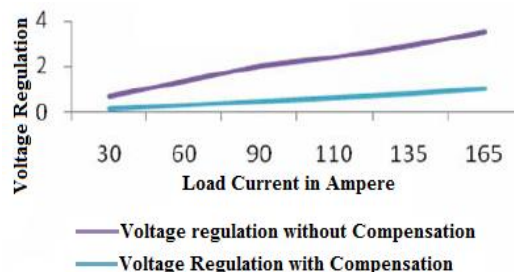

Fig 1- Effect of Compensation on Regulation

A. Load Flow Studies
Load flow or power flow analysis is the determination of the voltage, current, real power and reactive power at various points in electrical network. The information of load flow is essential for analyzing the effective alternative plans for system expansion to meet increase load demand.

B. Short Circuit Studies
A short circuit faults occurs in a power system due to insulation failure of the equipment or flashover of lines initiated by a lightning stroke or through accidental faulty operation. When a line, which has been made safe for maintenance by clamping all the three phases to earth, is accidentally made alive or

when due to slow fault clearance, an earth fault spreads across to the other two phases.

C. Transient Stability Studies

Transient stability is defined as the ability of the power system to remain in synchronism under large disturbance conditions such as fault and switching operations. The maximum power transfer limit is less than that of the steady state condition. Transient stability studies are conducted when new generating and transmitting facilities are planned. The studies are helpful in determining the nature of the relaying system needed, critical clearing time of circuit breakers, and voltage level and transfer capability between systems.

II. STATIC VAR COMPENSATOR

These are some well established static VAR compensation designs available in electrical sectors:

a. Series Controllers:

The series controller could be variable impedance such as capacitor, reactor or power electronics based variable source of main frequency, sub-synchronous and harmonic frequencies (or a combination) to serve the desired load. In principle, all series controllers inject voltage in series with the line. As long as the voltage is in phase quadrature with the line current, the series controller only supplies or consumes variable reactive power. Any other phase relationship will involve handling of real power as well. Series controllers include SSSC, IPFC, TCSC, TSSC, TCSR, and TSSR.

B. Shunt Controllers:

As in the case of series controllers, the shunt controllers may be variable impedance, variable source or a combination of these. In principle, all shunt controllers inject current into the system at the point of connection. Even variable shunt impedance connected to the line voltage causes a variable current flow and hence represents injection of current into the line. As long as the injected current is in phase quadrature with the line voltage, the shunt controller only supplies or consumes reactive power. Shunt controllers include STATCOM, TCR, TSR, TSC and TCBR.

C. Series-Series Controllers:

This could be a combination of separate series controllers which are controlled in a coordinated manner, in a multiline transmission system or it could be a unified controller in which series controllers provide independent series reactive compensation for each line but also transfer real power among the lines via the proper link. The real power transfer capability of the unified series-series controller makes it possible to balance both real and reactive power flow in the lines and thereby maximize the utilization of the transmission system.

D. Series-Shunt Controllers:

This could be a combination of separate shunt and series controllers which are controlled in a coordinated manner or a UPFC with series and shunt elements. In principle, combined shunt and series controllers inject current into the system with the shunt part of the controller and voltage in series in the line with the series part of the controller. However when the shunt and series controllers are unified, there can be a real power exchange between the series and shunt controllers via the proper link. Combined series-shunt controllers include UPFC, TCPST, and TCPAR.

III. METHODOLOGY

The technique discussed in this paper is basically based on Static VAR compensator to handle reactive power management. A controller is used to operate the switching ON and OFF the circuit.

A) SVC with Switched Capacitor:- SVC can be used for coordinating impedance as well as conveys the power factor close to requirement. This part is more valuable to decrease the receptive power and enhance the power factor at any load conditions. When load is capacitive in nature then static VAR

compensator utilize thyristor controlled reactor for reducing the framework voltage and if load is inductive at that point naturally switch in capacitor bank.
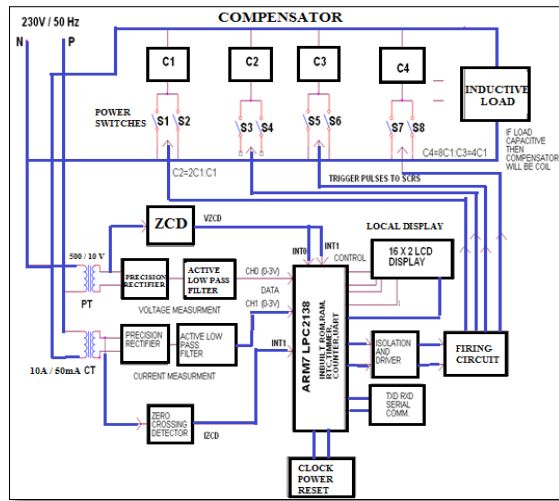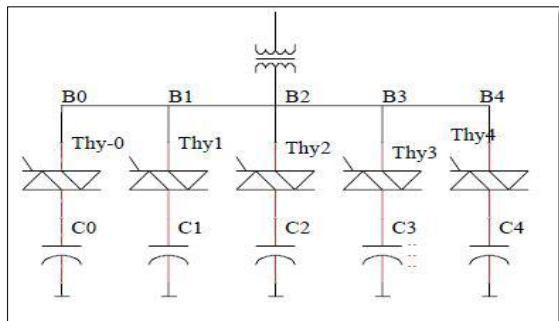

Fig 2- Implementation of Circuit

Fig.3- Thyristor Binary Compensation

b) Current Transformer / Potential Transformer:-
While measuring voltages and current with the help of ARM (LPC2148), proportional DC analog voltage is applied to its ADC. Capacity of CT and PT will depend upon load handling capacity and mains supply available. In our project work 5A/50 mA CT is used to sense the load current, which is connected in series with load. 230V to 6Vor 9V or 12V PT may be used to measure the voltage. Current capacity of PT is not important. Current capacity of PT up to 300 mA is suitable. In case of PT voltages ratio of primary and secondary is linear. In case of CT current ratio is important. Secondary current is directly proportional to primary current. Current ratio will depend upon the number of turns for secondary and primary. The

maximum secondary current will decide the value of Burdon resistor and required voltage across Burdon resistor.

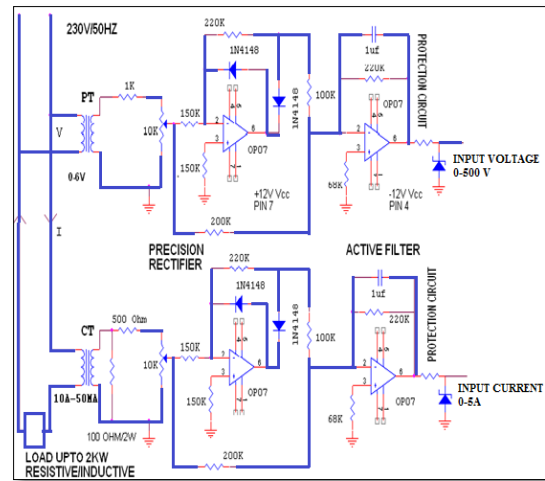*c) Precision rectifier's active filter:*

Fig.4: Precision Rectifier, Active Filter& Protection Circuit.

The initial block of the hardware is attenuator using 1K and 10K trim-pot. The required amount of input is applied to the rectifier block with the help of trim-pot. Calibration of voltages or current is achieved by varying 10K trim pot. Gain of the precision rectifier will depend upon feedback resistance and input resistance (R1). In present hardware selected R1 is 150K and feedback resistor is 220K. Ratio of these two will provide the gain of 1.33.
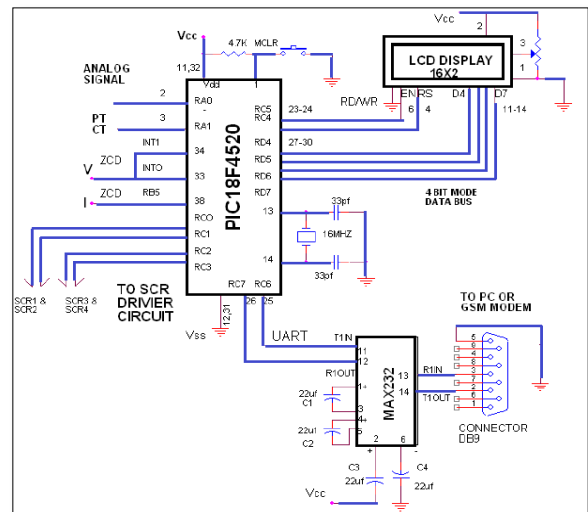

Fig.5- ARM interfacing circuit

Advantages of precision rectifier are that, it will overcome the problem of nonlinear characteristics of rectifier diode. Precise op amp 0P07 is used for this purpose. The active low pass filter circuit is designed using op amp 0P07 and RC filter circuit. Our line frequency is 50Hz. Time period t of cycle is 20 m sec, the time constant of filter circuit is very small than t hence circuit will act as a low pass filter. The output of filter circuit is pure DC and directly proportional to the input AC voltages or AC current of the system. The DC output of this block is applied to ADC of ARM.

d) ARM (LPC 2138):-

This processor ARM has 32 bit Advanced RISC (Reduced Instruction Set Computer) Machines, Additionally valuable for quick I/O operations, different 32bit timers, single or double 10-bit 8-channel ADC, 10-bit DAC, PWM channels and 47 GPIO lines with up to nine edge or level delicate external interrupt on pins make these microcontrollers reasonable for this framework.

e) SCR driver and isolation:-

A pulse is produced at zero-intersection moment of every half cycle. The span of half cycle for 50Hz AC mains is 10ms. The activating/terminating moment of each of the two SCRs by a most extreme length of 10ms regarding the yield of the converter as wanted. Consequently the lines conveying trigger pulse from the microcontroller to the converter area must be confined to maintain a strategic distance from high voltages coming to the microcontroller.

f) Capacitor Bank Selection:-

Capacitor bank will be chosen by the required interest for PF change. For separate bank terminating point is shifted to accomplish PF near solidarity.

IV. WORKING AND DISCUSSION

A single phase 230V/50 Hz supply is used, which is given to the current transformer (CT) as well as potential transformer (PT) to adjust the current and voltage as per our requirement. The output of CT/PT gives to precision rectifiers because small changes can't be detected by normal rectifiers also framework required DC signal for operations. Precision rectifier can't get a pure DC output therefore we can use active low pass filters. Then this pure DC output is given to the controller for measurement of reactive power.
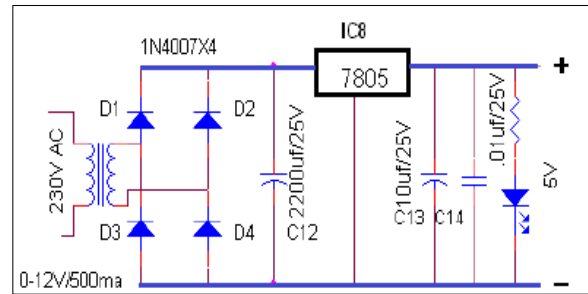

Fig 6- Regulated Supply Circuit

Zero crossing detectors can convert sine wave in square wave format because ARM microcontroller only understands digital input. The zero crossing detectors gives interrupt signal to the ARM controller. Then the ARM can calculate the phase difference between voltage and current. By using this phase difference the active power, reactive power and apparent power is calculate. The selection of capacitor bank depends upon reactive power. After the selection of capacitor bank we can reduce the reactive power losses.

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