Reactive Power Compensation By Thyristor Switched Reactor (TSR) In SVC FACTS

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Abstract- *This project is basically designed to implement FACTs in power system. We know that when there is low load or charging of transmission line the receiving end voltage is greater than sending end due to effect of capacitance form in medium and long transmission line. Various types of insecurities and venerable types of faults and other insecurities are present in power system due to which power system equipment like transformer, bus bar, generator, etc. get affected so we need fast and reliable method to control. All thing is control by FACTs technology effectively and in less time. This projects give you as much information on the cure of increased voltage in receiving end side due to capacitance effect called as Ferranti effect with the help of FACTs technology.*

I. INTRODUCTION

FACTs- FACTs are the new technology in which we use the electronic component like mosfet, gto, scr, etc. we use as for fast and reliable operations for protection and securities purposes called FACTs technology. Facts controllers are the device which is used to protect the power system components, facts controllers are like SVC, TCSC, UPFC, etc.

FERRANTI EFFECT- when there is no load or low load in receiving end side of power system the receiving end side of voltage is increased as nearly doubles of sending end voltage due to capacitance effects which are form in medium and long transmission line called Ferranti effect. Due to Ferranti effect or we say that voltage amplification can cause insulation failure and damage of power system components.

SVC(STATIC VAR COMPENSATOR)- it is the facts technology in which we use back to back combinations of scr or other electronic component in series with inductor or capacitor called SVC type FACTs controller.

TSR (thyristor switched reactor)- in which we use back to back scr in series with reactor called tsr.

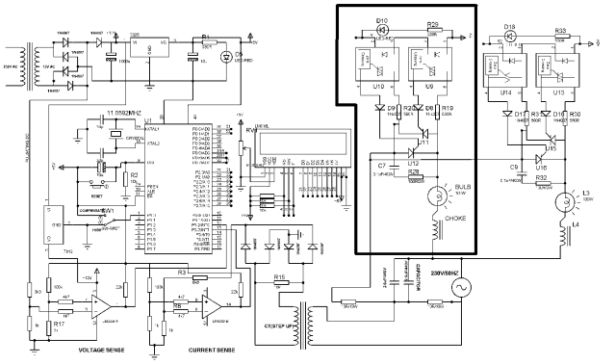
To enhance controllability and reliability back to back scr we used in which we control firing and conduction angle. Firing angle is adjusted between 180 to 90 degrees for working and best results.

$$I_{TSR} = \frac{\sqrt{2}V}{X}(\cos\alpha - \cos\omega t)$$

Where I_{TSR} is the tsr current,
V is the rms voltage applied,
X is reactance,
Alpha (α) is firing angle.

II. PROPOSED MODEL

In this model we used two no. of capacitor each of 2.5µF rating connected in parallel so total capacitance is 5µF act as natural capacitance formed in transmission line power system. In this proposed model we use choke, SCR, current transformer, transformer(23.0/12V), voltage regulator, microcontroller(ATMEL) series, LCD, capacitors, resistor of different ratings, crystal oscillator, etc. these all components makes a facts model. The aim of this model is to reduce the voltage amplification when the switches is turned on. As in normal mode the capacitance effect is there so receiving end voltage is high so when the compensation mode is on so voltage is being compensation is takes place. The proposed model as shown in figure:



Block diagram represents the proposed facts circuit.

III. PRESENT SYSTEM

In present time in some places India the power system is runs an old system so there is a lot problem faced by

engineer and this problem is cure by conventional method. So there is a lot of improvement is needed to implement the FACTs technology. So we know that we electronic switching elements like scr, gto, etc. in FACTs technology. We know that important thing to balance the reactive power flow in power system. When power is not flow in proper manner that is unbalance manner so we need to balance it for perfect flow of power so we need to compensate this using FACTs technology in our project we use SVC(static var compensator) in this we use TSR(thyristor switched reactor).

There are two type of reactance in power system that is inductive and capacitive reactance. When there is more inductance in power system so it cause voltage reduction in receiving end side so we need capacitance reactor connected in parallel in receiving end side to compensate this. Again when there is capacitance is more in power system so it because the bad power factor and voltage amplification that is Ferranti effect in power system so we use inductive reactor in parallel in receiving end side to compensate this effect.

DISADVANTAGE:

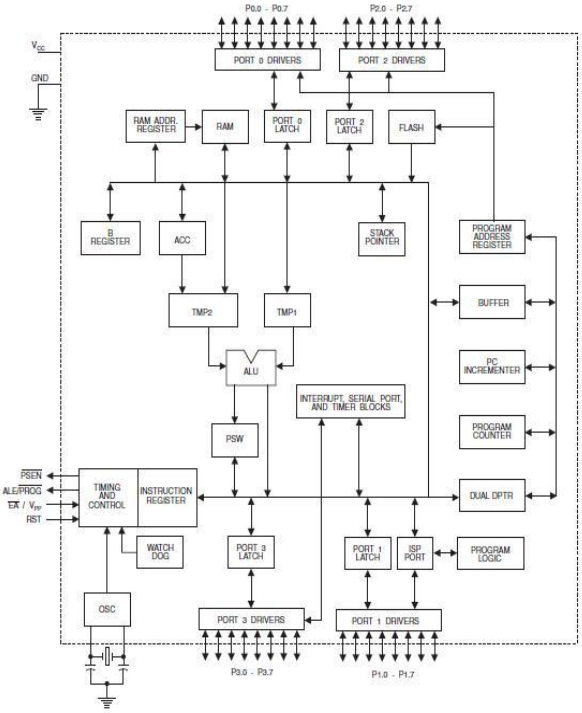
Following are some disadvantages of present system are:

- Lagging power factor, which very Important to compensate this because of saving cost and losses too.
- Losses is more in present system.
- One of the main disadvantage is that also current carrying capacity is less when it require more current it is uneconomical due to increase in losses.

IV. COMPONENTS

1. **ATMEL MICROCONTROLLER**-microcontroller is set of ram, rom, memory, interrupt, and other components to perform specific and unique work call microcontroller. In this we ATMEL AT89S52.

BLOCK DIAGRAM OF ATMEL MICRONTROLLER



Following are the specifications of microcontroller are:

- External data memory of 64Kb.
- Internal data memory is of 256 bytes.
- It has erasable read only memory.

2. **CHOKE**-in power electronic circuit choke is used to limit the current. Generally choke is made up of inductor and resistor both. A coil of insulated wire which is wound around a core of magnet is present in a choke while in some cases a choke also consists of doughnut shaped "bead" of magnetic material wound on a wire. The impedance of the choke increases as we increase the frequency of the supply system. The low electrical resistance of a choke allows both the AC and DC current to pass with either low or no loss of power but the amount of AC current that can be passed through a choke is limited by reactance of the choke being used.

3. **TRANSFORMER**- transformer is a static device which transform electrical energy from one circuit to another. This work on the principle of mutual induction between two winding of transformer. In this operation the frequency and power is constant throughout the process. In this project we use two transformer one is step down transformer of rating 230/12 volts. Which gives supply to the regulator, and all microelectronic components used in circuit. And transformer that is current transformer used in this circuit for need of comparison of time lag between voltage and current waveform purpose.

4. **VOLTAGE REGULATOR**- voltage regulator is use to regulate the power supply or it is used to maintain the constant voltage level. In this project we use IC 7805 it means that integrated circuit 78 series and 05 indicates the voltage level. This voltage regulator is used in primary side in PCB circuit. This voltage regulator is used in AC or DC purpose both.

5. **QUAD VOLTAGE COMPARATOR**- This family of devices consists of four independent precision-voltage comparators with an offset voltage specification as low as 2 mV maximum for LM339A, LM239A, and LM139A. Each comparator has been designed specifically to operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible.

These comparators also have a unique characteristic in that the input common mode voltage range includes ground even though operated from a single power supply voltage
These comparators also have a unique characteristic in that the input common-mode voltage range includes ground, even though they are operated from a single power supply voltage. The LM339 series was designed to directly interface with TTL and CMOS. When operated from both plus and minus power supplies, the LM339 series will directly interface with MOS logic where their low power drain is a distinct advantage over standard comparators.

Features

- Wide Supply Ranges
- Low Supply-Current Drain Independent of Supply Voltage: 0.8 mA (Typical)
- Low Input Bias Current: 25 nA (Typical)
- Low Input Offset Current: 3 nA (Typical) (LM139)
- Low Input Offset Voltage: 2 mV (Typical)

V. RESULT TABLE AND CALCULATION

Following are the result table shows the different voltages at different conditions:

NORMAL VOLTAGE (V)	INCREASED VOLTAGE DUE TO CAPACITANCE (V_1)	COMPENSATED VOLTAGE (V_c)
230	234	213
234	237	226
237	233	230

- **SURGE INPEDANCE**

For balance reactive power in transmission system,
$X_C=X_L$……..1
$X_C=636.656\Omega$
From Equation 1 We Calculate Inductance,
L=0.0020284mH
Surge impedance=$\sqrt{\frac{L}{C}}$=636.65Ω

- **VAR PRODUCED**

$=V^2/X_C$
$=230^2/636.94=83.0256$var

- **SURGE IMPEDANCE LOADING**

$= V^2_{L-L}/X_L$
=77.524W

VI. FUTURE SCOPE

This project can be improved by controlling the firing angle and this gives the best methodology to implement and set the system in future in big power system. We use better switching element like gto, scr, etc. for improving the operation time and reliability which in used in FACTs devices.

APPLICATIONS

1. Mitigation of flicker.
2. Control of power flow in transmission line.
3. Stability of steady state voltage in power system.
4. Generation cost reduction Application to HVDC link in power system.
5. Power system oscillation damping

VII. CONCLUSION

This project is basically designed to implement FACTs in power system. We know that when there is low load or charging of transmission line the receiving end voltage is greater than sending end due to effect of capacitance form in medium and long transmission line. Various types of insecurities and venerable types of faults and other insecurities are present in power system due to which power system equipment like transformer, bus bar, generator, etc. get affected so we need fast and reliable method to control. All thing is control by FACTs technology effectively and in less time.

Due to this, amplification of voltage takes place (known as Ferranti Effect) which results in the increase in voltage at the receiving end. The receiving end voltage

becomes double as compared to the sending end voltage (in case of medium and long transmission lines). In order to compensate for the same, shunt inductors are introduced across the transmission line automatically

REFERENCE

[1] FACTS controller in power transmission and distribution by K.R PADIYAR (ISBN-13-9788122425413) (2007)
[2] Understanding facts by N.G HINGORANI, L.GUIGYI. IEEE press ISBN-0780334558(2000)
[3] Reactive power compensation using facts devices under non sinusoidal condition. Sarvesh A. Gadre, Praveen S. Iyer (2015).
[4] Ferranti effect compensation using TSR in facts. Anupriya,Monika Saharan, Nishant Jakhar, NawneetRoy Chaudhary (2017).
[5] Review on facts devices integrated with TSR (2015).
[6] Review on comparison of facts devices controller for power system stability Enhancement.Vireshkumar G Mathad, Basangouda F Ronad (2013).
[7] An article on flexible ac transmission system. Amranth sanyal, Archita ghose, Raju basak, Sourish sanyal, Shubhashree chaterjee, Deepyan biswass (2016).
[8] Facts using TSR. Rishab Jain, Sunil kumar sahu, C. Venkata Srikar, Rohit, Suvit Chitnis, Mr Mauson Sharma (2017).
[9] Facts controller installation and benefits. Naresh Acharya, Mithulananthan Nadarajah, A.sode yome (2005).
[10] How to facts controller benefits AC transmission line.Jhon J pasarba. Fellow IEEE.