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Improvement of Power Factor in a Transmission Line Level using STATCOM

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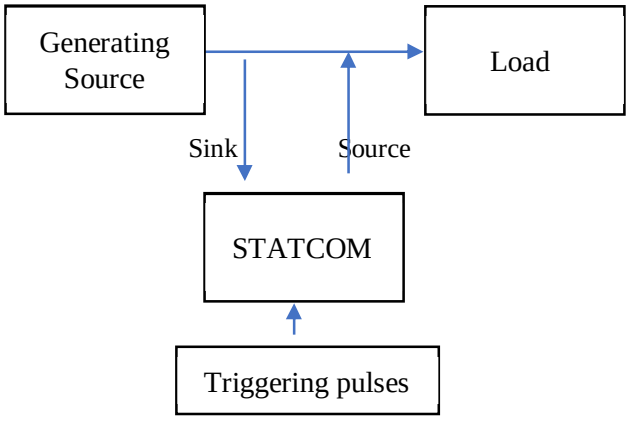
Abstract: ***The theme in the project is going to describe how the STATCOM is used for the correction of power factor in the transmission line. The presence of reactive power causes the real power to be less than the apparent power, and so, the electrical load has the power factor of less than unity. This study deals with low power factor issues and its improvement technique.***
A Static Synchronous Compensator (STATCOM) is implemented at transmission level for meeting reactive power demand of load for improving power factor to unity and for regulating voltage. The detailed modeling for this project will be simulated using MATLAB.
Keywords: Power factor correction, STATCOM, Voltage Source Converter (VSC).

I. INTRODUCTION

The Modern world relies increasingly on electrical power requires high demands in quality of power. Maintaining power quality is an important factor in the power system development and improvement. The term unity in power factor plays a key role in the power system. The Power factor correction is very essential in transmission system due to presence of electrical loads. Power loss is due to poor power factor in the distribution system with more inductive loads. The purpose of power factor correction is due to lag in reactive power with inductive loads. Because of the presence of lag/lead in reactive power, the presence of active power to be low in the transmission line. This makes the power factor less than unity. To improve this power factor, we traditionally had some compensating techniques, they are

Generator excitation regulation, Synchronous compensator, Series compensation capacitor, Switching in/out of the shunt reactor or shunt capacitor, FACT devices Among all the above techniques the FACTS are more reliable and are commonly used for compensation. Improving the PF can maximize current-carrying capacity, improve voltage to equipment, reduce power losses, and lower electric bills. The simplest way to improve power factor is to add PF correction capacitors to the electrical system. PF correction capacitors act as reactive current generators. They help offset the non-working power used by inductive loads, thereby improving the power factor. The interaction between PF capacitors and specialized equipment, such as variable speed drives, requires a well-designed system. There by to improve the power factor, a special technique is used (i.e. FACT devices).

II. PROPOSED BLOCK DIAGRAM



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III. MATLAB SIMULINK MODEL

In the MATLAB Simulink we taken two types of model, one is without using STATCOM (i.e. without compensation) and the other is using STATCOM (i.e. with compensation). The below figure shows the detailed Simulink model of parallel transmission system with RL load without compensation.

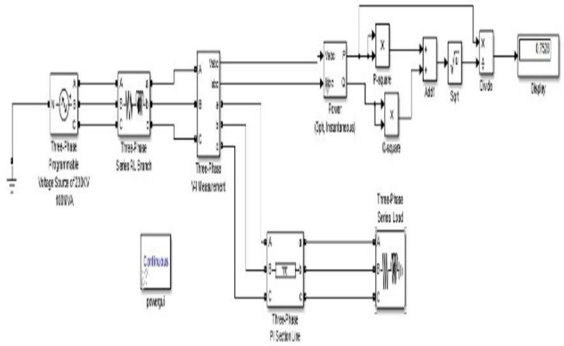

Figure 1: System without STATCOM

The system is said to be stable when the real power in KW is equal to the reactive power in KVAR i.e. KW=KVAR. When the inductive load is connected to the transmission line then there will be a cause of real power due to change in reactive power which is absorbed by the inductive load and the power factor will also decrease. To get the system to be stable we should use some compensation techniques which is so called STATCOM.

we can derive the power factor with an equation as shown below.

$$cos\emptyset = P \div S$$

$$S = \sqrt{(P^2 + Q^2)}$$

$$cos\emptyset = P \div \sqrt{(P^2 + Q^2)}$$

Where 'P' indicates Active power, 'Q' indicates Reactive power and 'S' indicates Apparent power

By applying the active and reactive power values in above equation we get the power factor**.**

From fig:2 when we connect the STATCOM in transmission level it acts as both "Sink" and "Source". If it absorbs reactive power it acts as Sink and if it generates reactive power it acts as Source. If the generated reactive power is equal to absorbed reactive power, then the system is said to be stable.

$$Q_{generated} = Q_{absorbed}$$

As we discussed about the system without compensation, here we discuss about with compensation. The below MATLAB Simulink shows how the STATCOM is used and connected in transmission level

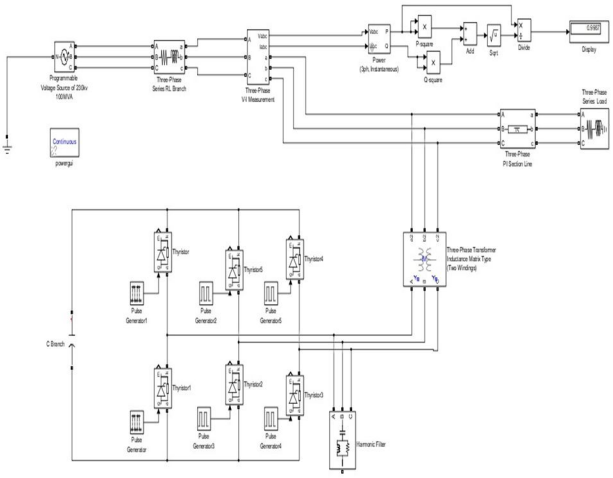

Figure 2: System with STATCOM

When there is a change in terminal voltage due to change in load, the active power change occurs and the power factor also various due to change in reactive power which is consumed by the inductive load. This error will be compensated using STATCOM. Here the STATCOM will generate the equivalent reactive power to maintain the system stable (i.e. $Q_{generated} = Q_{absorbed}$). Then the active power transfer capability can be increased in the transmission level, there by the power factor will be nearly unity as shown in table

IV. RESULTS

S.NO	Power required by load	power factor without Compensation	Power factor With Compensation
1	Active power= 10MW Inductive reactive power=5Mvar	0.5276	0.9947
2	Active power=10MW Inductive reactive power=10Mvar	0.6688	0.9943
3	Active power=5MW Inductive reactive power=15Mvar	0.6257	0.9941
4	Active power=5MW Inductive reactive power=10Mvar	0.4081	0.9944
5	Active power=10MW Inductive reactive power=30Mvar	0.7491	0.9936

By considering the operation, different loads are connected to the line for the improvement of power factor and the power factor has improved using STATCOM. By getting these results we will summarize that using a compensation device we should get power factor nearly unity

V. CONCLUSION

In this study of power factor improvement, power factor has improved by using shunt connected FACTS device i.e. STATCOM. We had studied the need of power factor improvement by STATCOM. The overall conclusions are:

A. Power factor is to be improved now-a-days in order to reduce the copper losses, size of the conductor and equipment size and to improve the voltage regulation.

B. STATCOM is a controlled reactive-power source. It provides the desired reactive-power generation and absorption entirely by means of electronic processing of the voltage and current waveforms in a voltage-source converter (VSC).

C. STATCOM has number of advantages over conventional methods of compensation viz; quick response time, less space requirement, optimum voltage platform, higher operational flexibility and excellent dynamic characteristics under various operating conditions.

D. STATCOM is better device then SVC. For country like Pakistan having large interconnected system the SVC is better option from economic point of view but due to other aspects like stability margin, voltage improvement and power system performance, STATCOM is preferred.

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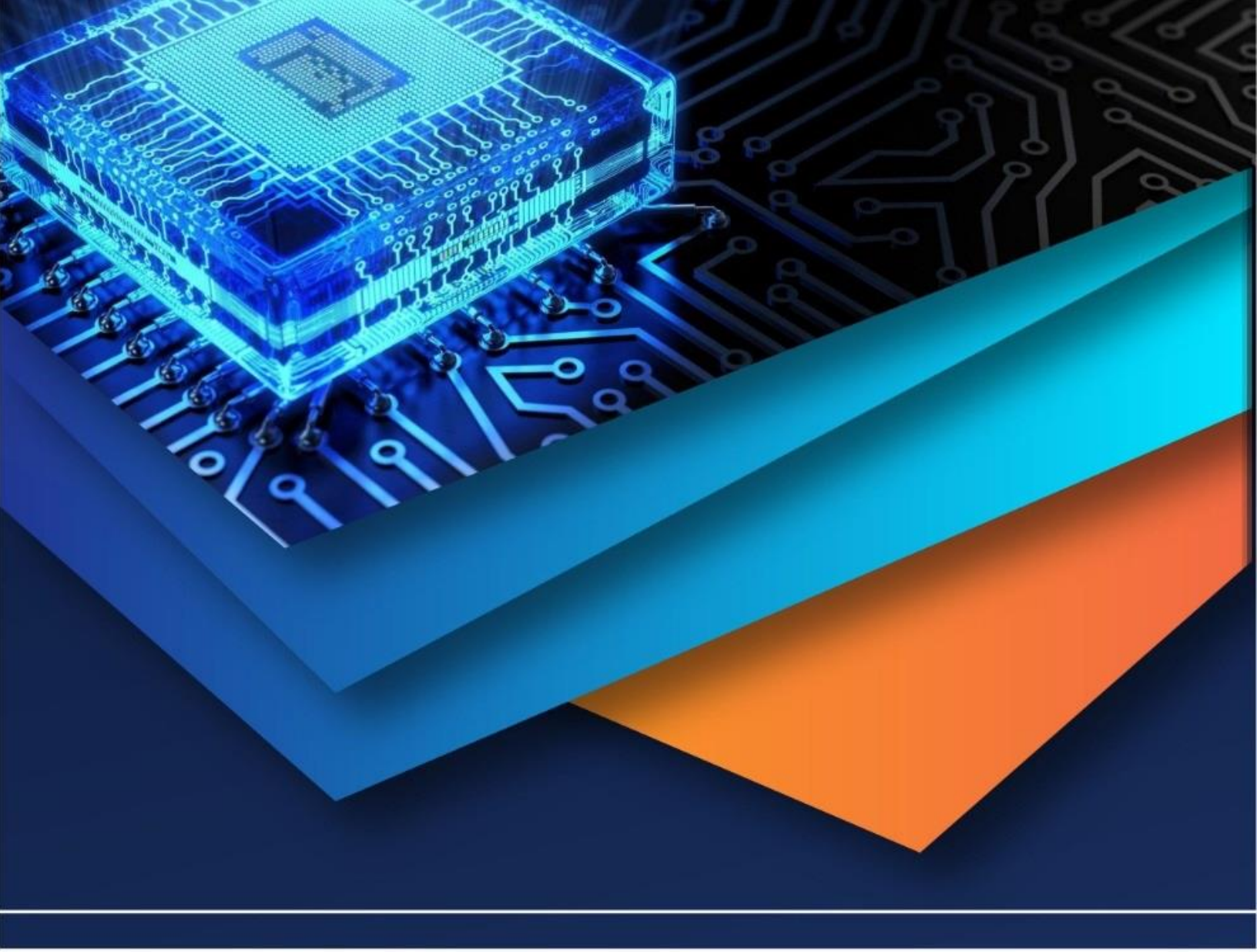

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