

Power System Stability Improvement in Multi-machine 14 Bus System Using STATCOM

Mohini¹, Kiran Rani², Urmila Bainsla³, Dr. Rajesh Kumar Ahuja⁴
^{1,2,3}(Research Scholar/YMCA university of Science and Technology, Faridabad, India)
⁴(Associate Professor, YMCA University of Science and Technology, Faridabad, India)

Abstract: *With the increasing variety of load and awareness of consumers, power system stability is becoming an important issue. Whenever the load is either switched on or off, the impedance of line changes. This change in impedance causes unbalance in total power supplied and total power demand. As power is directly proportional to square of voltage, so the magnitude of voltage is affected. As load in power system changes at rapid rate, the magnitude of voltage also changes at the same rate. Voltage stability also becomes important in case of transients. The power system is subjected to severe transient disturbance, due to a fault on transmission lines, loss of a large load or sudden loss of generation. The ability of a power system to maintain synchronism when subjected to a severe transient disturbance is called transient stability. In this paper the transient stability of power system is improved using STATCOM (Static Compensator) in a multi-machine 14 bus system using Matlab/simulink. The study shows that STATCOM improves the voltage, active power, reactive power, rotor speed and rotor angle stability.*

Keywords-*Flexible AC Transmission Systems (FACTS), Matlab/simulink, Static Compensator (STATCOM), Transient Stability,.*

I. Introduction

In early days of development of power system, the demand and utility was far less than modern days of globalization and privatization of system. In modern scenario the use of electricity is increasing. The effect of which is in terms of increasing demand of electricity. To meet the required demand there are two ways- one is to enhance the power generation and other is to utilize the available power in a better way. The former is less possible because of limited resources available. Thus main emphasis lies on the latter technique. With the introduction of power electronics devices in the field of controlling and handling the power quality issues, the systems are becoming more reliable and stable[1][2]. FACTS devices which are fast in operation and have no rotating parts are such power electronics converters widely used to improve power quality issues. The FACTS devices can be used to control impedance, voltage, phase angle etc. of high voltage AC lines. By using FACTS devices power system stability can be improved satisfactory. STATCOM is a type of FACTS device which can provide advantages like improving system voltage, damping power system oscillations and controlling power flow in the line. STATCOM is very efficient in improving the overall transient stability of the system [3].

II. Static Compensator (STATCOM)

STATCOM consist of a inverter made up of IGBT or GTO acting as self commutated switches , a DC voltage source an interconnecting transformer, and controller which controls the switching time of various switches in inverter legs. The STATCOM is capable of generating continuously variable inductive or capacitive shunt compensation at a level up its maximum MVA rating. The STATCOM constantly checks the line waveform with respect to a reference ac signal, and therefore, it can provide the correct amount of leading or lagging reactive power compensation to reduce the amount of voltage fluctuations. If the output voltage of the voltage source converter is greater than the system voltage then the STATCOM will act as capacitor and generate reactive power otherwise it will act as inductor to absorb reactive power[4][5][6].

III. Simulation Results And Interpretation

Simulink model of a fourteen bus system with five generating units and fault is shown in Fig 3.1 which is simulated in MATLAB. Five generators of 96MVA, 64MVA, 247.5MVA, 64MVA and 96MVA are used and a total load of 315MW and 115MVAR is used. A single phase fault is connected between bus8 and bus14. Various measurements blocks and scopes are connected to observe the variation of voltage, active power, reactive power, difference of rotor speeds oscillations and difference of rotor angle oscillations. This Fig 3.1 shows that when a fault occurs in a Fourteen bus system with five generating units without STATCOM. The effect of fault of very short duration which is applied between 5.1second to 5.4 second is observed on voltage,

active power, reactive power, difference in rotor speed oscillations and difference in rotor angle oscillations is seen[7][8].

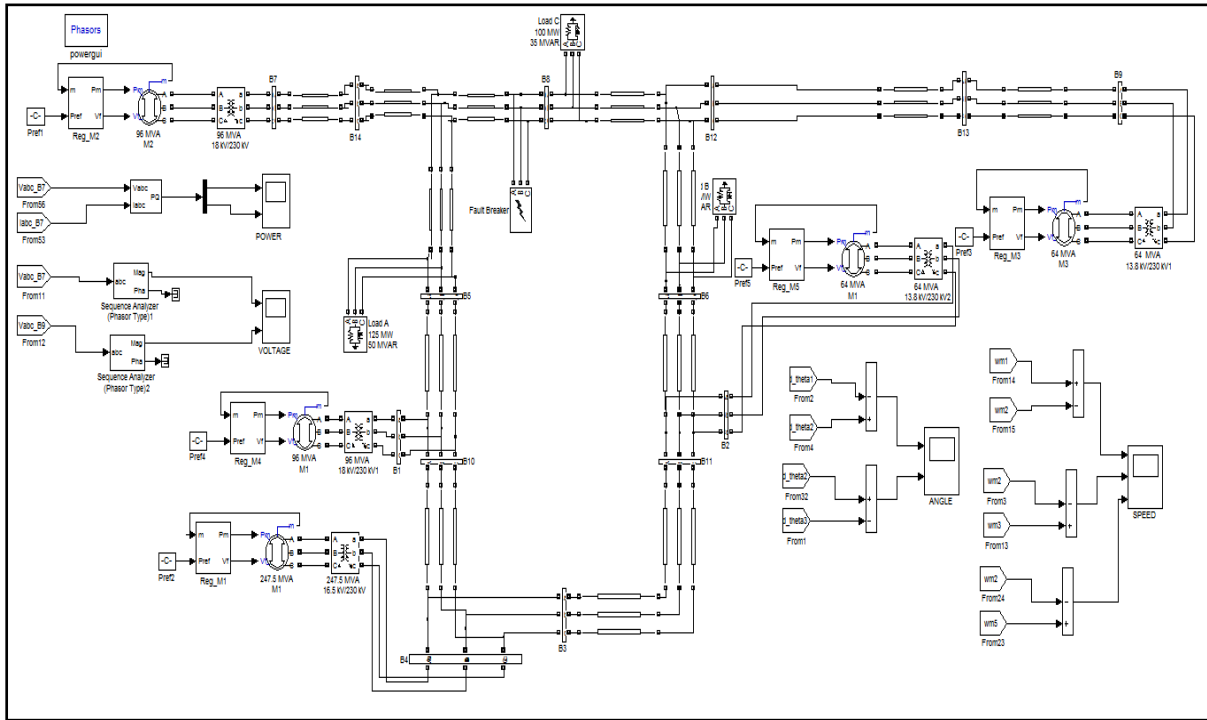


Figure 3.1 Simulink model of a 14 bus system with five generating units and fault

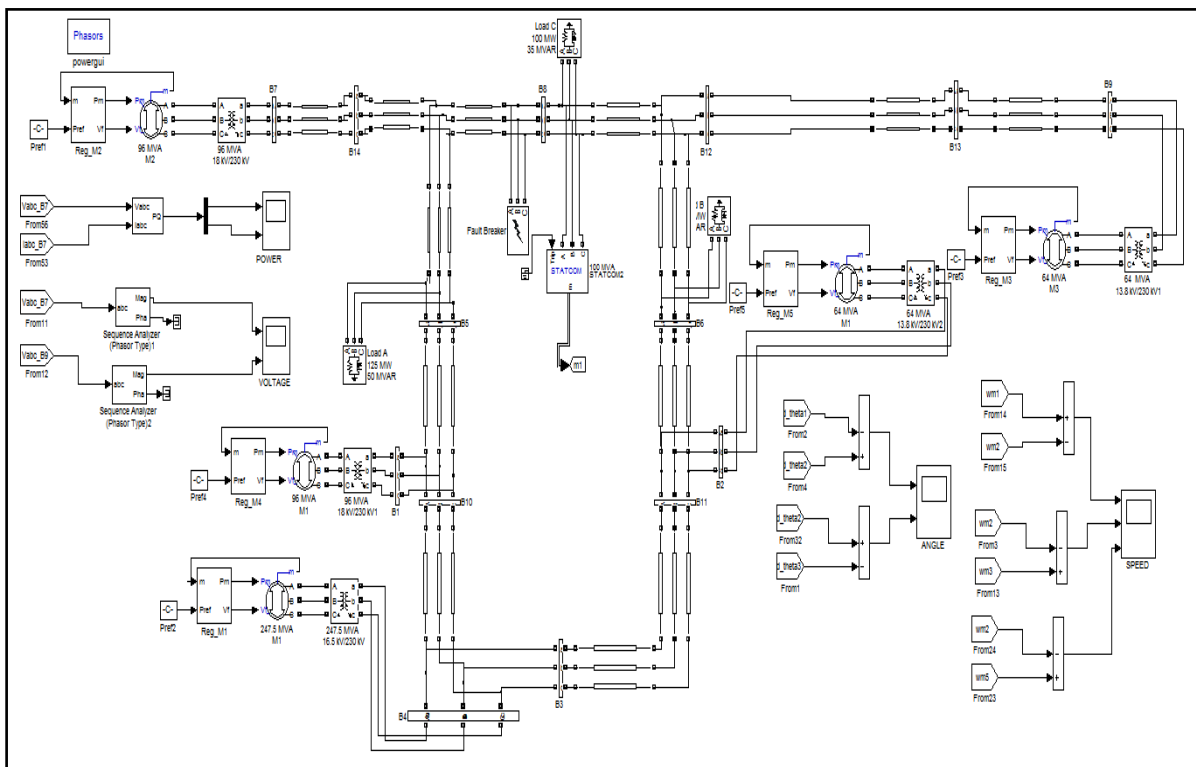


Figure 3.2 Simulink model of a 14 bus system with five generating units and fault with STATCOM

Output Waveforms

The comparison of output waveforms without STATCOM and with STATCOM are observed as:

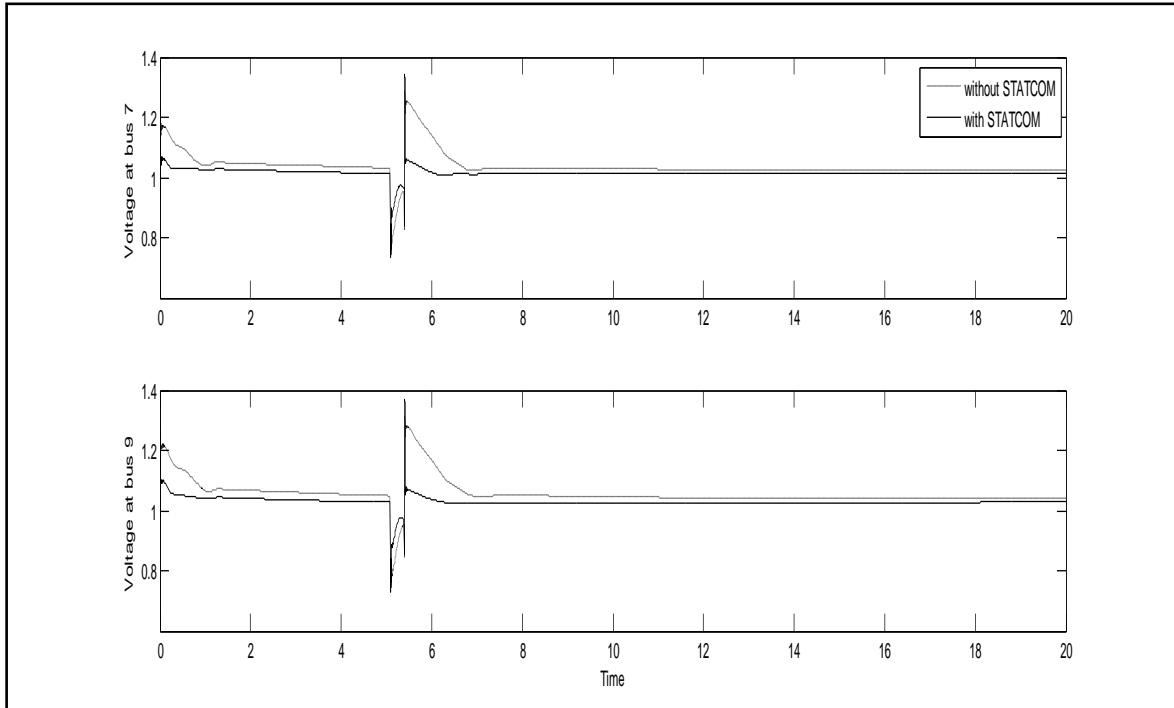


Figure 3.3 Comparison of output waveforms of Voltages at bus 7 and bus 9 when fault occurs without STATCOM and with STATCOM

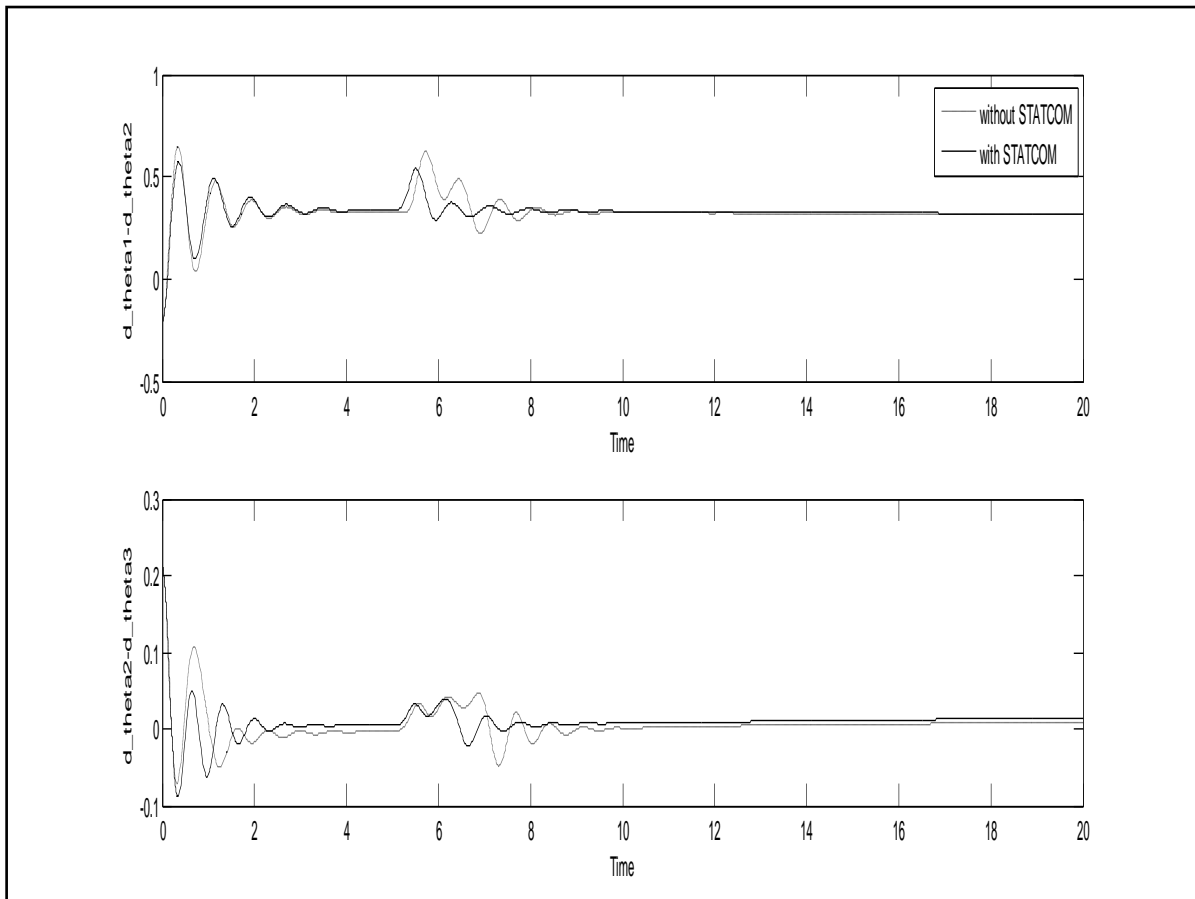


Figure 3.4 Comparison of output waveforms of difference in rotor angle oscillations when fault occurs without STATCOM and with STATCOM

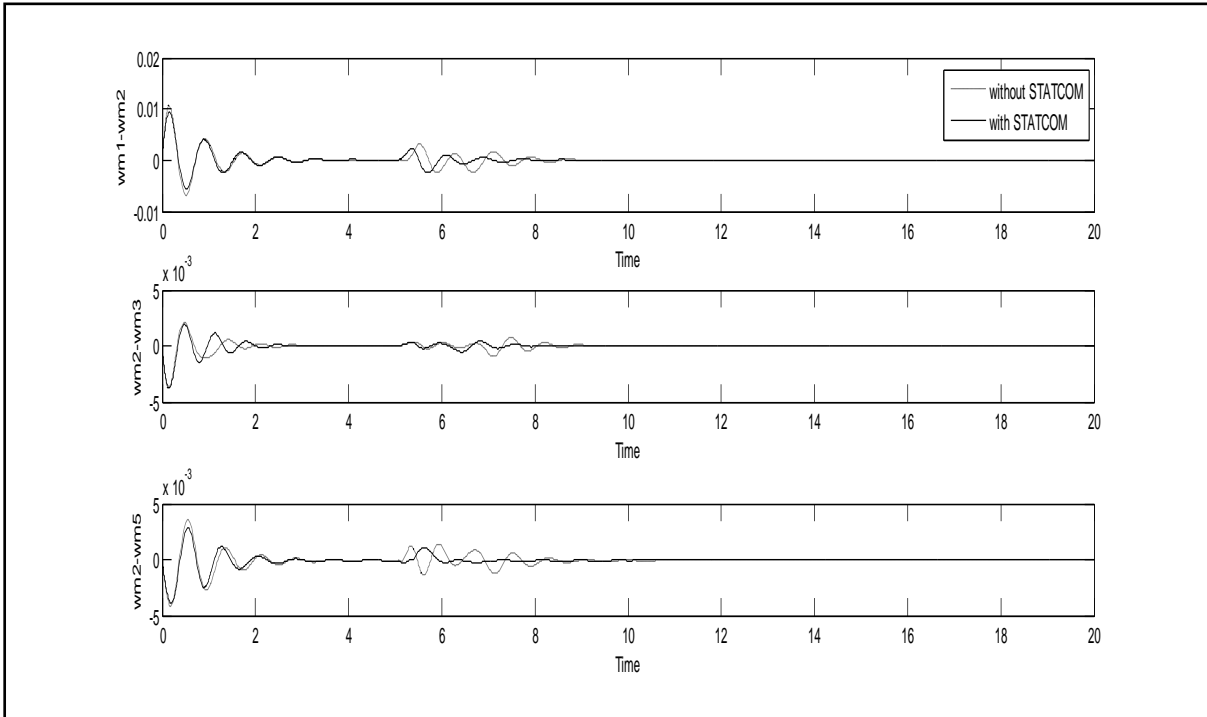


Figure 3.5 Comparison of output waveforms of difference in rotor speed oscillations when fault occurs without STATCOM and with STATCOM

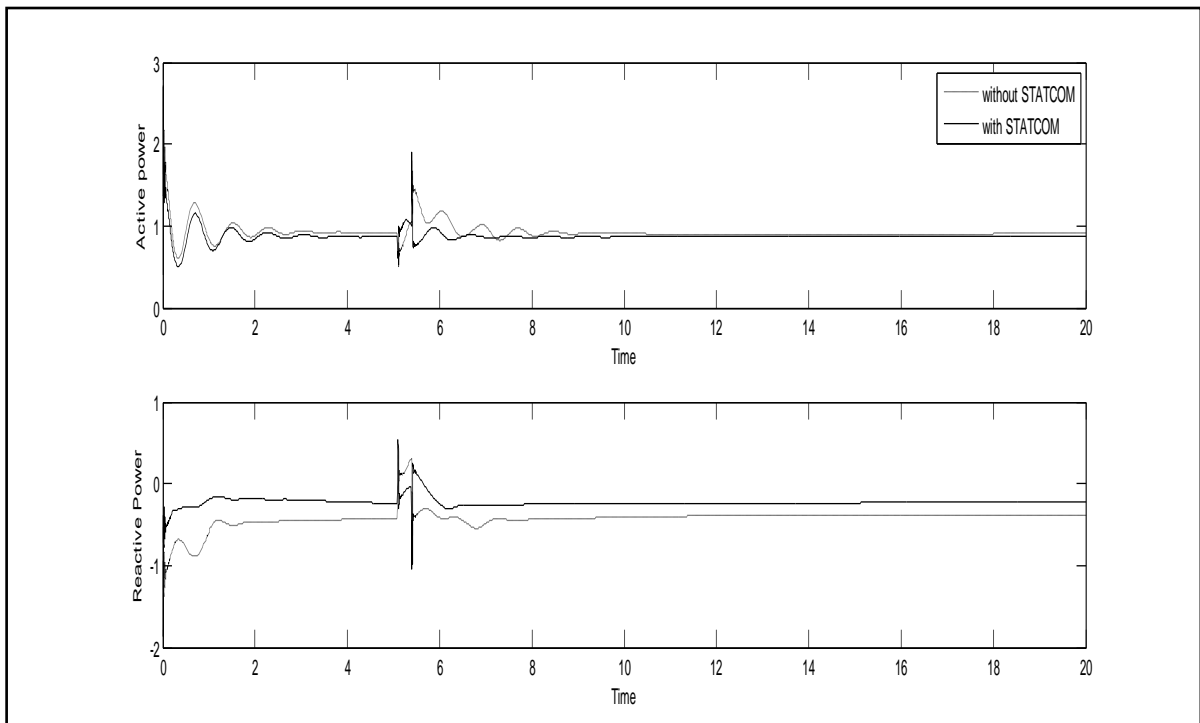


Figure 3.6 Comparison of output waveforms of active power and reactive power at bus7 when fault occurs without STATCOM and with STATCOM

The waveforms shown above clearly indicates that STATCOM damp out the power system oscillations very efficiently. It is very efficient in improving power system voltage stability. These shows that whenever a fault or transient causes the power system oscillations in voltage, active power and reactive power, then the settling time of the system can be reduced with the help of STATCOM. It also improves the settling time of the difference of rotor angles oscillations and difference of rotor speed oscillations and thus helps in maintaining the system synchronized faster.

IV. Conclusion

In this paper the advantages of STATCOM to improve the power system stability are shown. STATCOM damp out the power system oscillations very efficiently. The result shows that whenever a fault or transient causes the power system oscillations in voltage, active power and reactive power, then the settling time of the system can be reduced with the help of STATCOM. And the system is able to regain its stability quickly. This paper shows that STATCOM damp out the power system oscillations very fast in a system whenever there is a disturbance occur in a system due to fault of very short duration .Rotor angle stability and rotor speed synchronism is also improved. The overall system stability is improved.

References

- [1]. Alok Kumar Mohanty and Amar Kumar Barik, "Power System Stability Improvement Using FACTS Devices", International Journal of Modern Engineering Research (IJMER), Vol.1, Issue.2, pp: 666-672, ISSN: 2249-6645.
- [2]. P. Kundur, "Power System Stability and Control", McGraw-Hill, Inc., 1994.
- [3]. Ranjit Kumar Bindal," A Review of Benefits of FACTS Devices in Power System", International Journal of Engineering and Advanced Technology (IJEAT), Volume-3, ISSN: 2249 – 895, Issue-4, April 2014, pp:105-108.
- [4]. Sai Kiran Kumar,Sivakoti,Y.Naveen Kumar and D.Archana, "Power Quality Improvement In Distribution System Using D-Statcom In Transmission Lines", Vol. 1, Issue 3, pp.748-752.
- [5]. Md. Nazrul Islam, Md. Arifur Kabir, and Yashiro Kazushige, "Design and Simulation of STATCOM to Improve Power Quality", International Journal of Innovation and Applied Studies, Vol. 3 No. 3 July 2013, pp. 871-878.
- [6]. Pranesh Rao, Zhiping Yang, "STATCOM Control for Power System Voltage Control Applications", IEEE transactions on power delivery vol.15,no.4,October 2000,pp 1311-1317.
- [7]. Pull Venkata Kishore,S.Rama Reddy and P.V Kishore, "Modelling and simulation of 14 bus system with D-STATCOM for power quality improvement",Indian J.Sci.Res 3(1),pp 73-79,2012.
- [8]. Shervin Samimian Tehrani, "Shunt Compensation for Improvement of Voltage Stability Using Static Synchronous Compensator (STATCOM) for Various Faults in Power System", IJAREEIE, Vol. 3, Issue 6, June 2014.