

Stability Performance Enhancement of Smib System Using Facts Controller

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Abstract: The Objective of thesis is to study the transient stability under the 3-phase fault with and without controllers. Transmission networks of modern power systems are becoming increasingly stressed because of growing demand and restrictions on building new lines. One of the consequences of such as stressed system is the threat of losing stability following a disturbance. Flexible ac transmission system (FACTS) devices are found to be very effective in a transmission network for better utilization of its existing facilities without sacrificing the desired stability margin. Flexible AC Transmission System (FACTS) such as Static Synchronous Compensator (STATCOM) and Static Synchronous series Compensator (SSSC), employ the latest technology of power electronic switching devices in electric power transmission systems to control voltage and power flow. A static synchronous compensator (STATCOM) is a shunt device of the flexible AC transmission systems (FACTS) family. The STATCOM regulates voltage at its terminal by controlling the amount of reactive power injected into or absorbed from power system. When system voltage is low, STATCOM generates reactive power and when system voltage is high it absorbs reactive power. In this Thesis different STATCOM controllers i.e. based on SMIB system based are designed for improving transient stability of single machine infinite bus (SMIB) systems. Proposed controllers are implemented under MATLAB/SIMULNK environment. Results of Controllers installed with SMIB system and compared with STATCOM between SSSC controllers.

The fundamental structure of a strength machine is as proven in Fig.1. It is composed of generating vegetation, a transmission system and distribution gadget. These subsystems are interconnected via transformers T1, T2 and T3 and Generator G. Basically energy system structures are mixture of Mainly 3 components generating plant, transmission device, and distribution device. In producing plant the power is generated by means of electrical system which consist greater sort of device which include generator, turbine, transformer and so on. The generated electricity is transmitted to transmission line via heavy capability of conductor and transmitted energy is transferred to distribution machine. Distribution gadget provide the electricity to consumer (load) that are related to distribution gadget which include industrial client , home customer, business purchaser and so on. The shape of energy system is shown as

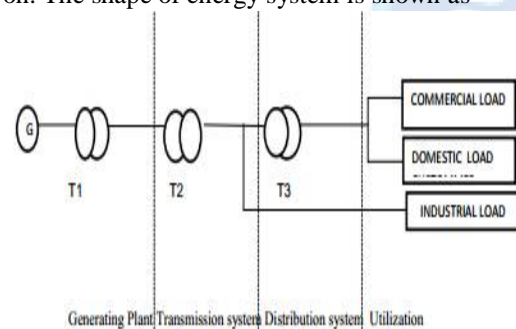


Fig.1. Structure of Power System

1. Introduction:

The power structures these days are complicated networks with hundreds of generating stations and cargo facilities being interconnected thru energy transmission traces. An electric powered strength machine can be subdivided into 4 stages:

- 1) Generation
- 2) Transmission
- 3) Distribution and
- 4) Utilization (load).

The power device is an exceedingly nonlinear system that operates in a constantly changing environment; loads, generator outputs, topology, and key running parameters change always. When subjected to a temporary disturbance, the stability of the gadget depends on the nature of the disturbance as well as the initial working situation. The disturbance may be small or big. Small disturbances in the shape of load changes occur constantly, and the device adjusts to the converting conditions. The device ought to be capable

of operate satisfactorily below those conditions and correctly meet the load demand. It need to additionally be capable of continue to exist numerous disturbances of a severe nature, including a quick-circuit on a transmission line or loss of a large generator. Now-a-days its miles becoming very hard to fully utilize the prevailing transmission device property because of diverse reasons, inclusive of environmental rules, capital funding, rights of ways issues, construction cost of recent strains, deregulation policies, and so forth. Electric utilities are actually pressured to function their gadget in the sort of way that makes higher utilization of present transmission facilities. Flexible AC Transmission System (FACTS) controllers, primarily based on the fast improvement of energy electronics technology, have been proposed in recent years for better utilization of existing transmission facilities. With the improvement of FACTS method, it turns into possible to increase the electricity drift controllability and beautify energy machine 'as balance. Recently, Flexible Alternative Current Transmission System (FACTS controllers have been proposed to enhance the brief or dynamic balance of energy structures. During the closing decade, some of control devices below the time period FACTS technology had been proposed and implemented. Application of FACTS gadgets in electricity structures, leads to higher overall performance of device in lots of elements. Voltage stability, voltage law and strength gadget stability, damping may be improved via the use of those gadgets and their right control. There are diverse kinds of FACTS gadgets, a number of which are linked in series with a line and the others are linked in shunt or a mixture of collection and shunt. The FACTS technology is not a single excessive strength controller however instead a collection of controllers which can be carried out in my opinion or in coordination with other to control one or more of the inter associated gadget parameters like voltage, contemporary, impedance, segment attitude and damping of oscillations at numerous frequencies under the rated frequency. Among all FACTS gadgets, static synchronous compensators (STATCOM) plays a good deal extra important role in reactive energy reimbursement and voltage assist due to its appealing regular nation overall performance and operating characteristics. The fundamental precept of a STATCOM mounted in a energy device is the technology ac voltage supply by way of a voltage source inverter (VSI) related to a dc capacitor. The lively and reactive energy switch among the strength system and the STATCOM is because of the voltage distinction throughout the reactance. The STATCOM can also boom transmission capacity, damping low frequency oscillation, and improving brief stability. The STATCOM is represented by way of a voltage source, which is connected to the gadget thru a coupling transformer. The voltage of the source is in segment with the ac machine voltage on the point of connection, and the magnitude of the voltage is controllable. The modern-day from the supply is restrained to a maximum cost via adjusting the voltage. Mathematical modeling and analysis of static

compensator (STATCOM) is provided in [5]. It explains the usage of STATCOM for development of transient stability and power transfer. In 1881 two electricians built the world's first power machine at Godalming England. It changed into powered by means of a electricity station inclusive of water wheels that produced an alternating cutting-edge that in flip furnished seven Siemens arc lamp sat 250 volts and 34 in can descent lamps at 40 volts. However deliver to the lamps was intermittent and in 1882 Thomas Edison and his business enterprise, The Edison Electric Light Company, developed the first steam powered electric power station on Pearl Street in New York City The Street Station to start with powered around three,000 lamps for 59 customers. The energy station used direct contemporary and operated at a unmarried voltage. Direct present day power could not be without problems converted to the better voltages necessary to limit energy loss at some stage in long distance transmission, so the maximum economic distance between the mills and load become constrained to around half- a- mile (800 m).

2. Related Work:

In recent years, electricity call for has expanded significantly whilst the expansion of electricity technology and transmission has been significantly restrained because of restrained sources and environmental regulations. As a outcome, a few transmission strains are heavily loaded and the device stability turns into a strength transfer-limiting thing. Flexible AC transmissions structures (FACTS) controllers have been mainly used for fixing various power gadget consistent kingdoms manage issues. However, latest research reveals that FACTS controllers might be hired to decorate strength device stability similarly to their most important feature of electricity flow manipulate. The literature suggests an increasing hobby on this subject for the final a long time, where the enhancement of machine stability the use of FACTS controllers has been notably investigated. Transmission networks of present electricity systems have become steadily more confused due to increasing demand and boundaries on building new traces. One of the effects of one of this careworn gadget is the risk of losing balance following a disturbance. Flexible ac transmission system (FACTS) gadgets are found to be very green in a stressing transmission network for better usage of its current facilities without sacrificing the preferred stability margin. Flexible AC Transmission System (FACTS) controllers, inclusive of Static VAR Compensator (SVC) and Static Synchronous Compensator uses the modern era of strength electronic switching gadgets in electric powered strength transmission structures to control voltage and strength glide, and play an crucial function as a balance resource for and transient disturbances in an interconnected electricity structures by N. G. Hingorani, and L. Gyugyi, 2000 The literature suggests an growing interest in this subject for the final two a long time, wherein the enhancement of device stability the use of FACTS controllers has been considerably investigated. This paper affords the improvement of transient

balance of a two region strength machine with a SVC. Transient stability development is vital from the view point of retaining machine security that is the prevalence of a fault has to no longer cause tripping of generating unit due to loss of synchronism. SVC has the capacity of enhancing balance and damping by way of dynamically controlling its reactive electricity output. The brief stability development of the SMIB machine with exclusive loading conditions is investigated on these paintings provides a complete overview at the research and tendencies in the strength system stability enhancement using FACTS controllers. The static synchronous compensator (STATCOM) is one form of FACTS devices which resembles in many respects a rotating synchronous condenser used for voltage manage and reactive electricity repayment. The STATCOM can increase transmission capacity, damping low frequency oscillation, and enhancing brief balance work by way of S. Panda, and Ramnarayan M. Patel, 2006 This paper [9] affords a control block diagram of STATCOM for the brief balance development. The SIMULINK/MATLAB software package deal is used for simulation of check machine. In this paper the STATCOM is connected to the 230KV line for peculiar single machine transmission machine. The have a look at demonstrates that STATCOM now not only notably improves brief, stability but additionally compensates the reactive energy in constant state. In massive energy gadget the mills are of usually synchronous type, so it's miles essential to maintain synchronism with the grid to be able to provide preferred service to patron. The disturbance in energy machine is especially because of surprising trade of heavy load, faults, and lack of excitation. In this paper, the rate of exchange of temporary energy of the gadget is taken into account i.e. the dissipation of kinetic electricity (K.E.) of the power machine because of disturbances as a measure of device damping. To offer extra damping within the power gadget without extra value, the output power of the FACTS gadgets like STATCOM and SSSC already connected in the strength system for reimbursement is used. They modulate the machine output, to be able to lessen the system oscillation and therefore balance improves [10]. Static Synchronous Compensator (STATCOM) is a strength digital based totally tool that has capability of controlling the electricity go with the flow via the road by way of injecting appropriate reactive power to strength device. This work investigates the effect of STATATCOM on inter-place energy gadget stability. The STATCOM is modeled because the variable susceptance and is included into the model of power system by way of Dr.Tarlochan Kaur and Sandeep Kakrany, 2012.

3. Methodology:

“A Static synchronous compensator is a shunt-connected static var compensator who’s capacitive or inductive output modern-day can be managed unbiased of the ac gadget voltage” The concept of STATCOM changed into proposed by Gyugyi in 1976. Power Converter hired within the STATCOM specifically of types i.e. Is Voltage Source Converter and

Current Source Converter. In Current supply Converter direct contemporary constantly has one polarity and the strength reversal takes region through reversal of dc voltage polarity even as In Voltage Source Converter dc voltage always has one polarity, and the strength reversal takes region through reversal of d current polarity. The power semiconductor devices utilized in present day supply converter calls for bidirectional voltage blocking off capability and for reaching this Characteristic an extra diode have to be related in series with a semiconductor transfer which increased the machine value and its will become costlier as compared to voltage source converter moreover Voltage supply converter can function on higher efficiency in excessive electricity programs. Because of the above motives Voltage supply converter is Preferred over Current source converter and now in recent times it act as a fundamental digital block of a STATCOM that converts a dc voltage at its enter terminals right into a three-segment set of ac voltages at essential frequency with controllable significance and segment perspective. In STATCOM exclusive technology used structured upon the power rankings of STATCOM. For better strength STATCOMs GTO primarily based technologies are used at the same time as for lower electricity STATCOMs IGBT primarily based technologies used.

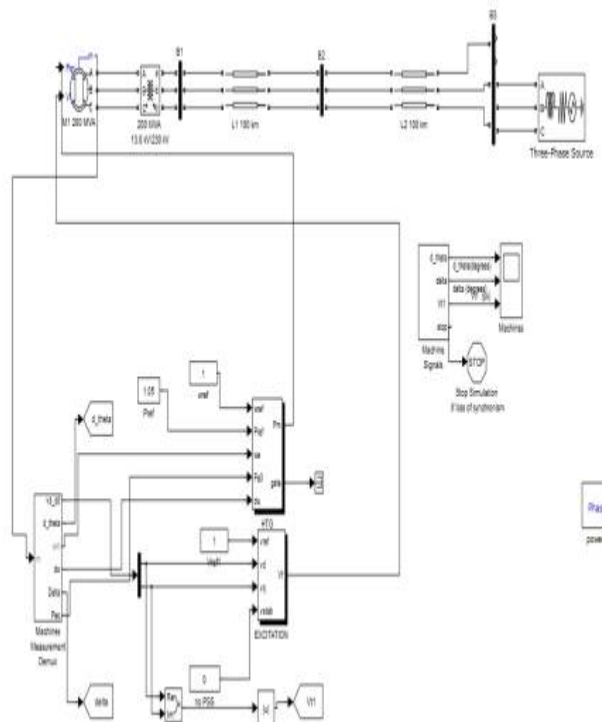


Fig. 2. Simulation model of SMIB system without controller

Static: based on solid state switching devices with no rotating components.

Synchronous: analogous to an ideal synchronous machine with 3 sinusoidal phase voltages at fundamental frequency.

Compensator: provided with reactive compensation

Statcom Design:

The STATCOM layout it contains there is following parts including voltage source converter (VSC), DC capacitor, and inductive reactance and so on.

The figure shows the single machine infinite bus system without FACTS controller.

Simulation Model of SMIB System without Controller (under three phase Fault)

The model shows the simulation model of SMIB under three phase fault without controller. the following component which included in model that are given as following , The system operates in steady state in stable condition. During the fault the in the system the rotor angle increase suddenly and power transfer is maximum during the fault but this is not well indication to long time because machine may loss synchronism and system will be unstable. And during the fault machine speed is high because mechanical power is more than electrical power and system voltage become reference voltage. Which causes system becomes unstable. The simulation model without controller is shown in fig 3

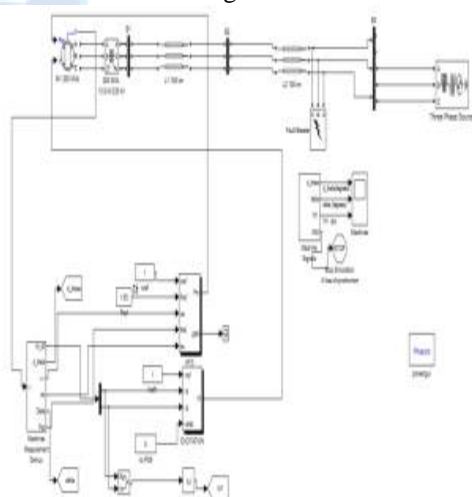


Fig. 3. SMIB model under three phase fault without controller

4. Result and Discussion:

Simulation result of SMIB model without controller (under three phase Fault)

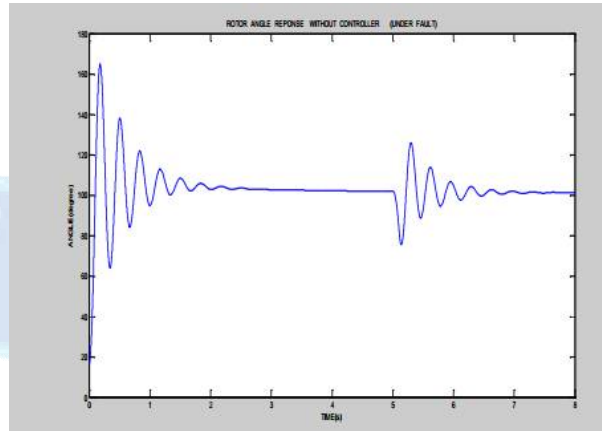
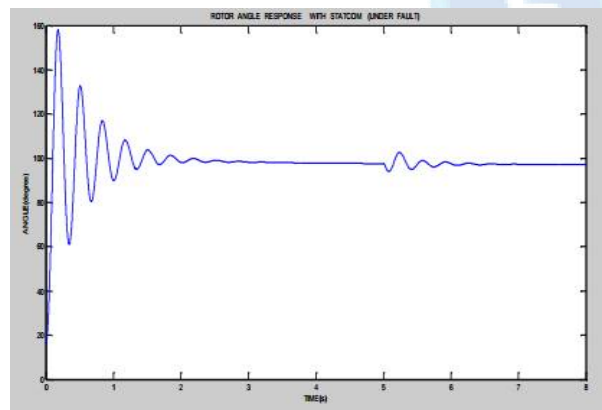


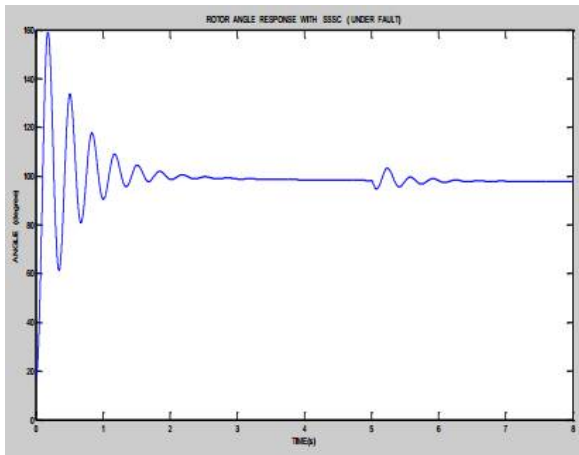
Fig. 4. Plot of rotor angle response of SMIB model without controller (under fault)

Simulation result of SMIB model with STATCOM controller (under three phase fault)



This table 1 shows the numerical value response of rotor angle settling time, overshoot, and rise time under three phase fault without controller and with controller connected to SMIB system. The SVC has minimum rise time 1.9871×10^{-4} sec ,in case of settling time all are behaving almost similar at 4.6 sec approx. among them the SVC is giving least i.e. 4.6058sec.The overshoot is least in the UPFC and thereafter SVC i.e aprox. 74 and 77 at the almost similar peak time of aprox 3.018 sec.

Simulation result of SMIB model with SSSC controller (under three phase fault)



Comparative result of Rotor angle of SMIB system of Normal model, without controller, with STATCOM and SSSC (under three phase fault)

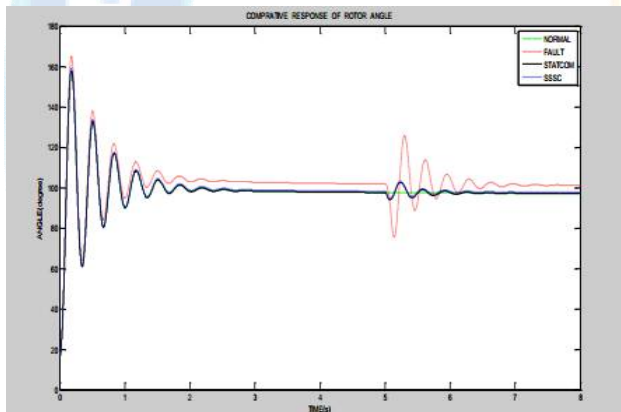


Table 1: COMPRATIVE RESULT OF ROTOR ANGLE

	Rise Time	Settling Time	%rcnt Overshoot	Peak Time
Statcom	2.5083e-04	4.6068	82.8023	3.0182
Svc	1.9871e-04	4.6058	77.0965	3.0183
Ssc	2.2393e-04	4.6087	79.3635	3.0182
Upfc	2.0932e-04	4.6307	74.2666	3.0180

5. Conclusion:

In this thesis, the effect of various FACTS devices for improving transient stability of the single machine power system is investigated in terms of the Fault Clearing Time. These devices (STATCOM , SVC , SSC and UPFC) are used to control power flow of power system by injecting appropriate reactive power during dynamic state. Computer simulation results show that SVC not only considerably improves transient stability but also compensates the reactive power in steady state. SVC is giving least settling time and rise time and in second level priority of giving least percent peak overshoot. Therefore SVC can increase reliability and capability of AC transmission system. Simulation studies have shown that the additional voltage/var support provided by an external device such as a SVC can significantly improve fault recovery by more quickly restoring voltage characteristics. The extent to which a SVC can provide support depends on its rating. The higher the rating, the more support provided. The SVC helps to provide better rotor angle characteristics during severe faults like three phase faults as well as.

In future we can also add optimized tuning of these device like GA PSO etc ti find out the best device parameter at the trade off device response time and overshoot. We can also incorporate modern artificial intelligence technique like fuzzy, ANN, ANFIS etc. controllers in a smart feedback mechanism that can adapt its parametric behavior with respect to variation in fault occurrence time.

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