Applications of FACT Devices in Power System Stability

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Abstract: Stability is one of the major concerns related to power system. The instability causes the fluctuations in different parameters of power system but the voltage and frequency are most importantly considered because may cause great damage and even cause complete shutdown of power system. This paper presents brief overview of different types of instabilities in power system and the techniques used to overcome it. The paper also compares the applicability of different techniques on the basis of performance.

Keywords: Power System Stability, FACT Devices, Static VAR Compensator, Static Synchronous Compensator

I Introduction

The stability of the power system is defined as "the ability of an electric power system, for a given initial operating condition, to regain a state of operating equilibrium after being subjected to a physical disturbance, with most system variables bounded so that practically the entire system remains intact" [1]. According to above definition it is clear that if system fails to get operating equilibrium then it will be called instable. There are many kind of instabilities exists in the modern power systems (such as voltage, frequency etc.) and accordingly the different stabilization methods are used [2, 3].

The stabilization processes basically works by compensation of the causing the instability in past this is done by connecting and disconnecting the capacitor, inductors or combination of both after that synchronous condenser, saturated reactor, thyristor controlled reactor, fixed capacitor thyristor controlled reactor, thyristor switched capacitor were used; but in present days this is performed by more advanced devices like STATCOM, VSC, TCSC etc [4, 5]. These devices evolves the intelligent controlling and fast switching power devices like MOSFET and IGBT the capability of fast switching makes them feasible for providing precise and smooth controlling. The intelligent controlling is performed by the complex calculations which are done by either analog circuits or microprocessors. Although analog devices performed well but in recent past developments in the semiconductor technology makes the digital controllers as first choice because of their capabilities and lower cost [6].

II Types of Instabilities in Power System

The classification to be introduced here is based on the physical mechanism being the main driving force in the development of the associated instability. Power System Stability

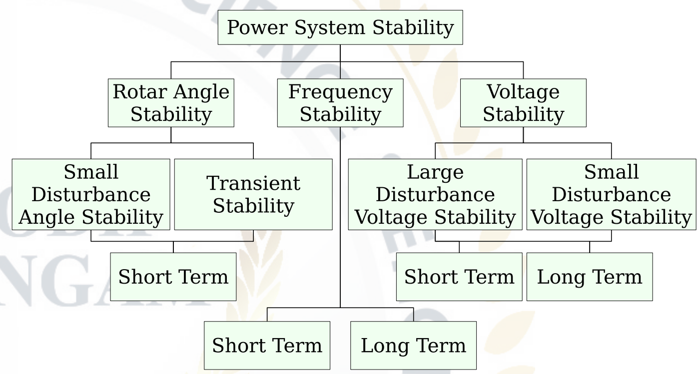

Figure 1: Block Diagram of Power System Stability

(PSS) problems may be classified as:

- Angle Stability
- Voltage Stability
- Frequency (Mid- and Long-Term) Stability

Each category can be divided into:

- Small-Signal (Dynamic) Stability: Determines if system remains in synchronism following a small disturbance (e.g., small load and/or generation variations).
- Transient Stability: Determines if system remains in synchronism following a major disturbance (e.g., transmission fault, sudden load change, loss of generation, line switching). The transient stability can further be divided into two classes.
  - First-Swing Stability: for 1st second after a system fault (simple generator model and no control model).
  - Multi Swing Stability: system analysis over long period of time (more sophisticated machine model)[7].

2.1 Rotor Angle Stability

The rotor edge soundness issue includes the investigation of the electromechanical motions inalienable in control frameworks. A crucial factor in this issue is the way in which the power yields of synchronous machines differ as their rotor edges change. The component by which interconnected synchronous machines keep up synchronism with each other is through reestablishing powers, which act at whatever point there are powers having a tendency to quicken or decelerate at least one machines as for different machines. Under enduring state conditions, there is harmony between the information mechanical torque and the yield electrical torque of each machine, and the speed stays consistent [8].

In the event that the framework is bothered, this harmony is vexed, bringing about quickening or deceleration of the rotors of the machines as indicated by the laws of movement of a pivoting body. In the event that one generator incidentally runs quicker than another, the precise position of its rotor in respect to that of the slower machine will progress. The subsequent precise distinction exchanges some portion of the heap from the ease back machine to the quick machine, contingent upon the power edge relationship. This has a tendency to lessen the speed contrast and consequently the precise partition

2.2 Voltage Stability

With respect to open power change the condition is not as clear and fundamental as concerning dynamic power. There is constantly a congruity among “conveyed” and “ate up” open power in every center of a framework. This is in sureness a prompt consequence of Kirchoff’s first present law. When one talks about unevenness in this setting we suggest that the injected responsive power is such, normally too little, that the voltage in the center point can’t be kept to commendable characteristics. (At low load the implanted responsive power could be high realizing a too high voltage, possibly higher than the rigging might be expected for. When we talk about unevenness for this circumstance we thusly suggest that the mixed responsive power contrasts from the pined for mixed open power, anticipated that would keep the pined for voltage. If this disparity gets too high, the voltages outperform the sufficient range.

2.3 Frequency Stability

Repeat robustness insinuates the limit of a power structure to keep up persevering repeat following a genuine system aggravate achieving a basic disproportion among age and load. It depends upon the ability to keep up/restore amicability between system age and load, with minimum coincidental loss of load. In security that may result occurs as upheld repeat swings inciting lurching of making units and weights. Genuine system foments generally result in huge excursions of repeat, control streams, voltage, and other structure factors, in this way conjuring the exercises of techniques, controls, and affirmations that are not shown in standard transient soundness or voltage trustworthiness inspects. These techniques may be direct, for instance, evaporator components, or actuated for preposterous system conditions, for instance, volts/Hertz protection lurching generators.

In broad interconnected power structures, this kind of situation is most regularly associated with conditions following piece of systems into islands. Quality for this circumstance is an issue of paying little respect to whether each island will accomplish a state of working parity with insignificant sudden loss of load. It is managed by the general response of the island as affirm by its mean repeat, rather than relative development of machines. Generally, repeat unfaltering quality issues are connected with insufficiencies in equipment responses, poor coordination of control and protection outfit, or lacking age hold.

III Contraption utilized for Enhancement of the Stability of Power System

The ordinary control contraptions like synchronous condenser, doused reactor, thyristor controlled reactor, settled capacitor thyristor controlled reactor, thyristor exchanged capacitor having less framework security confine, less difference in structure damping, less voltage shimmer control when showed up distinctively in connection to rising substances gadgets like TCSC, STATCOM and UPFC. This Section examines just FACT gadgets for structure solidness.

3.1 Static VAR Compensator (SVC)

Static VAR frameworks are connected by utilities in transmission applications for a few purposes. The main role is for the most part for fast control of voltage at powerless focuses in a system. Establishments might be at the midpoint of transmission interconnections or at the line closes. Static VAR Compensators are shunt associated static generator whose yields are changed to control voltage of the electric power frameworks. The SVC is associated with a coupling transformer that is associated specifically to the air conditioner transport whose voltage is to be regulated.[4]

Normally, a SVC contains at least one banks of settled or exchanged shunt capacitors or reactors, of which somewhere around one bank is exchanged by thyristors. Components which might be utilized to make a SVC normally include:

- Thyristor controlled reactor (TCR), where the reactor might be air-or iron-cored.
- Thyristor exchanged capacitor (TSC).
- Harmonic filter(s).

3.2 Thyristor Controlled Series Compensator (TCSC)

TCSC is a standout amongst the most vital and best well established FACTS gadgets, which has been being used for a long time to expand line control exchange and in addition to improve framework security. The fundamental circuit of a TCSC is appeared in Figure. The TCSC comprises of three principle segments: capacitor bank C, sidestep inductor L and bidirectional thyristors SCR1 (T1) and SCR2 (T2). The terminating edges of the thyristors are controlled to change the TCSC reactance as per a framework control calculation, typically because of some framework parameter varieties. As per the variety of the thyristor terminating point or conduction edge, this procedure can be displayed as a quick switch between comparing reactance offered to the power framework.

3.3 Static Compensator (STATCOM)

It is a gadget associated in deduction, fundamentally made out of a coupling transformer, that serves of connection between the electrical power framework (EPS) and the voltage synchronous controller (VSC), that creates the voltage wave contrasting it with the one of the electric framework to understand the trading of receptive power the STATCOM alters at every minute the opposite voltage so the current infused in the system is in quadrature to the system voltage, in these conditions $P = 0$ and $Q = 0$.

The STATCOM utilizes a VSC interfaced in shunt to a transmission line. As a rule the DC voltage bolster for the VSC will be given by the DC capacitor of moderately little vitality stockpiling ability subsequently, in relentless state task, dynamic power traded with the line must be kept up at zero.With the dynamic power limitation forced, the control of the STATCOM is lessened to one level of flexibility, which is utilized to control the measure of responsive power traded with the line. As needs be, a STATCOM is worked as a useful likeness a static VAR compensator; it gives quicker control than a SVC and enhanced control.[6]

The paper discussed the distinctive sorts of instability issues related with control system it moreover analyzed the FACT contraptions, their working, Structure and position in charge structure. Finally an examination tablet is presented for relationship of the execution of FACT devices for different system conditions.. Finally it might be said that the paper gives a non logical illumination and a sensible relationship of different FACT.

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