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Power System Stability Enhancement Using Fact Devices

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Abstract -The development of the fashionable grid has crystal rectifier to associate degree increasing quality within the study of power systems, and conjointly presents new challenges to grid stability, and specially, to the aspects of transient stability and small-signal stability. thus grid engineers square measure presently facing challenges to extend the facility transfer capabilities of existing gear. this is often wherever the versatile AC Transmission Systems (FACTS) technology comes into impact with comparatively low investment, compared to new transmission or generation facilities. versatile AC gear (FACTS) devices use power natural philosophy elements to take care of controllability and capability of electric power system. The paper aims towards the performance of UPFC is compared with alternative FACTS devices like Static Synchronous Series Compensator (SSSC), Thyristor Controlled Series electrical device (TCSC), and Static volt-ampere Compensator (SVC) severally. The simulation results demonstrate the effectiveness of the UPFC on transient stability of the system.

Keywords: FACTS, SSSC, SVC, TCSC, Transient stability, STATCOM, UPFC.

1. INTRODUCTION

This Modern facility could be a complicated network comprising of various generators, transmission lines, type of hundreds and transformers. As a consequence of skyrocketing power demand some transmission lines square measure additional loaded than was planned once they were engineered. With the raised loading of long transmission lines, the matter of transient stability once a serious fault will become a transmission limiting issue.

The stability of a system determines whether or not the system will calm down to the initial or getting ready to the steady state once the transients disappear. Transient stability refers to the potential of a system to take care of operation within the event of enormous disturbances like multi-phase short-circuit faults or change of lines. The ensuing system response involves giant excursions of generator rotor angles and is influenced by the nonlinear power angle relationship. Stability depends upon each the initial operational conditions of the system and therefore the severity of the disturbance. Recent development of power natural philosophy introduces the utilization of versatile ac transmission (FACTS) controllers in power systems. FACTS controllers square measure capable of dominant the network condition in a very in no time manner and this feature of FACTS may be exploited to enhance the voltage stability, and steady state and transient stabilities of an entire facility.

2. CLASSIFICATION OF FACTS DEVICES

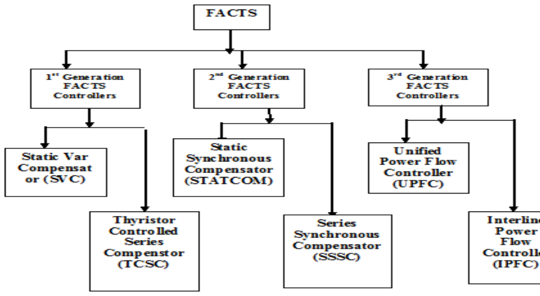

Fig2.1: Block Diagram of FACTS Controllers

2.1 THYRISTOR-CONTROLLED SERIES CAPACITOR

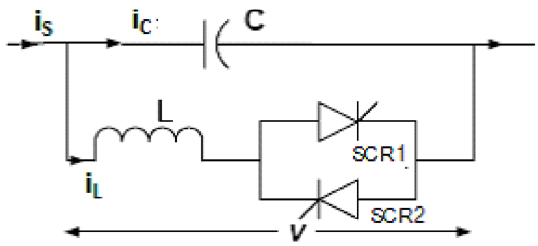

Fig2.2: Configuration of a TCSC

When the thyristors are fired, the TCSC can be mathematically

Described as Described as

$$i_c = C\frac{dv}{dt} \qquad v_l = L\frac{di}{dt}$$

$$X_{TCSC}(\alpha) = X_c - \frac{X_c^2}{(X_c - X_p)}\frac{(\sigma + \sin\sigma)}{\pi} + \frac{4X_c^2}{(X_c - X_p)}\frac{(\cos^2\sigma/2)}{(K^2 - 1)}\frac{K\tan\left(\frac{K\sigma}{2}\right) - \tan\left(\frac{\sigma}{2}\right)}{\pi}$$

Xc = Nominal reactance of the fixed capacitor C

X p = Inductive reactance of inductor L connected in parallel with C.

$\sigma = 2(\pi - \alpha)$ is conduction angle of TCSCcontroller.

K= $\sqrt{\frac{X_C}{X_P}}$= compensation ratio.

Thyristor Controlled Series condenser (TCSC) is one amongst the necessary members of FACTS family that's progressively applied with long transmission lines by the utilities in trendy power systems. It will have varied roles within the operation and management of power systems, like programming power flow; decreasing unsymmetrical components; reducing internet loss; providing voltage support; limiting short-circuit currents; mitigating sub synchronous resonance (SSR); damping the facility oscillation; and enhancing transient stability.

2.2 UNIFIED POWER FLOW CONTROLLER (UPFC)

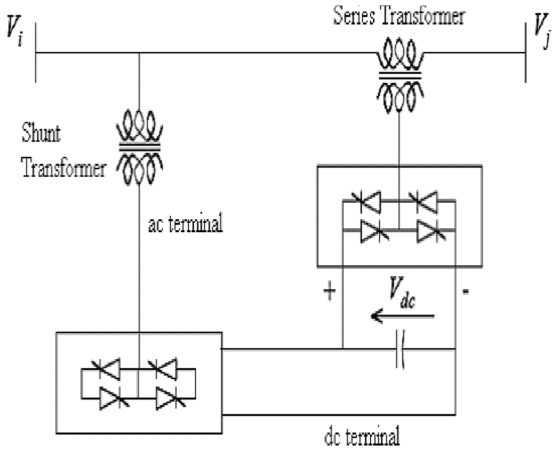

Fig2.3. Configuration of UPFC

The real and reactive power equations are as follows:

$$P = \frac{V_1 V_2}{X}\sin(\delta_1 - \delta_2)$$

$$Q = \frac{V_2}{X}(V_1 - V_2)$$

Among the accessible FACTS devices, the Unified Power Flow Controller (UPFC) is that the most versatile one which will be wont to improve steady state stability, dynamic stability and transient stability. The UPFC will severally management several parameters since it's the mix of Static Synchronous Compensator (STATCOM) and SSSC. These devices supply another mean to mitigate grid oscillations. it's been reported in several papers that UPFC will improve stability of single machine infinite bus (SMIB) system and multimachine system. A Static Synchronous Series Compensator (SSSC) could be a member of FACTS family that is connected asynchronous with an influence system. It consists of a solid state voltage supply device that generates a governable electricity voltage at harmonic. once the injected voltage is unbroken in construction with the road current, it will emulate as inductive or electrical phenomenon electrical phenomenon thus on influence the ability flow through the cable. whereas the first purpose of a SSSC is to manage power flow in steady state, it may improve transient stability of an influence system.

2.3 STATIC VAR COMPENSATOR (SVC)

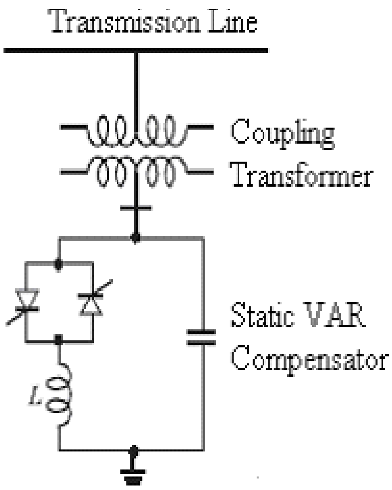

Fig2.4. Configuration of SVC

Static power unit Compensator (SVC) may be a 1st generation FACTS device that may management voltage at the desired bus thereby rising the voltage profile of the system. the first task of Associate in Nursing SVC is to take care of the voltage at a selected bus by suggests that of reactive power compensation (obtained by variable the firing angle of the thyristors). SVCs are used for top performance steady state and transient voltage management compared with classical shunt compensation. SVCs are accustomed dampen power swings, improve transient stability, and scale back system losses by optimized reactive power management.

SIMULATION DIAGRAMS AND RESULTS:

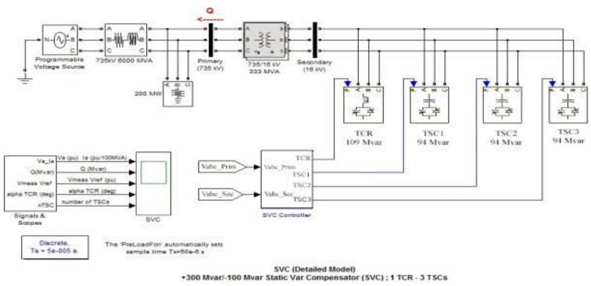

Fig3.1: Simulink block of Static var compensator(SVC)

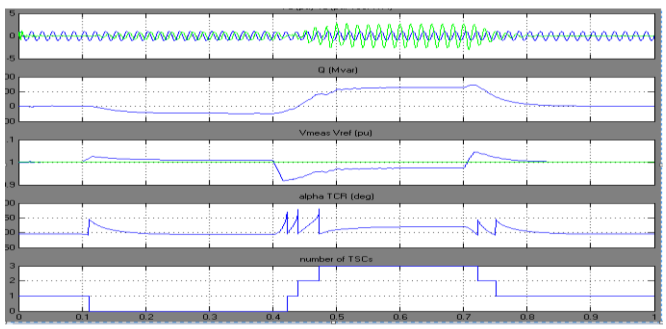

Fig3.2: SVC output

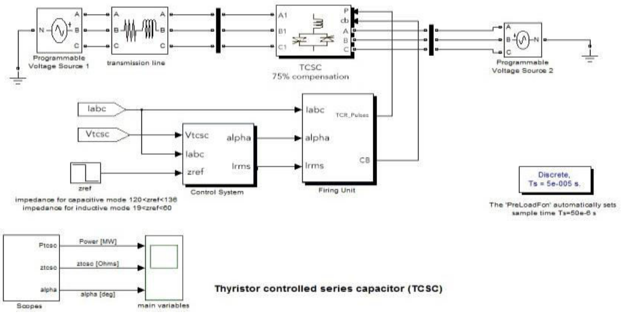

Fig3.3: Simulink block of Thyristor controlled series capacitor

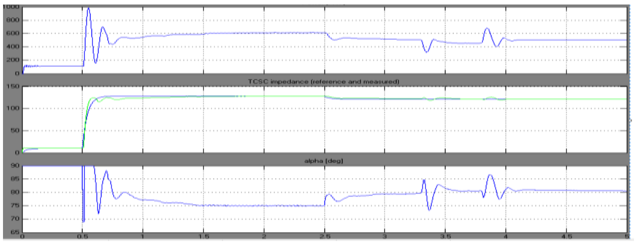

Fig:3.4: TCSC output

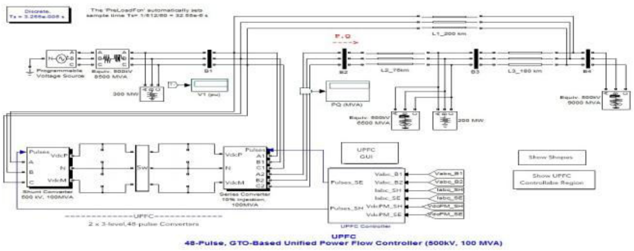

Fig 3.5: Simulink block of unified power flow controller

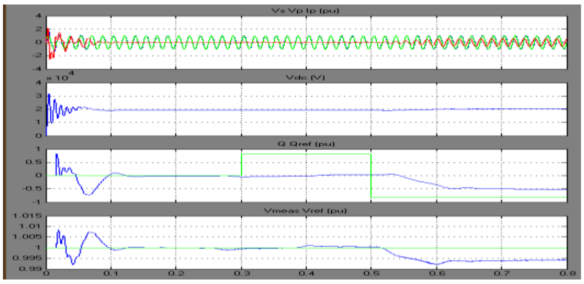

Fig 3.6: STATCOM(shunt) output

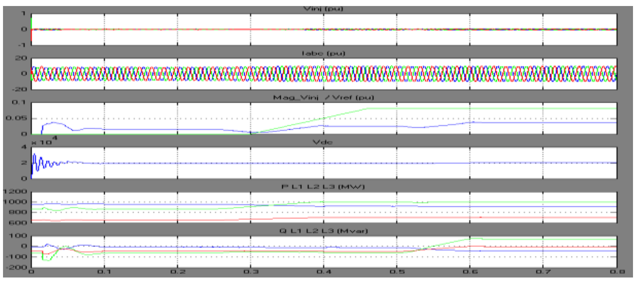

Fig 3.7:SSSC (series)output

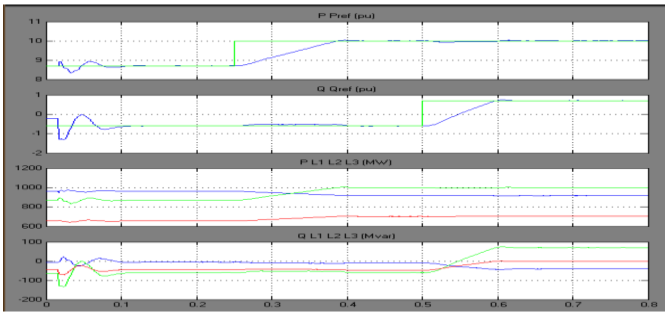

Fig 3.8: UPFC(series) output

3. COMPARISON BETWEEN FACTS DEVICES FOR POWER SYSTEM STABILITY ENHANCEMENT

TYPE OF FACTS DEVICE	POWERS YSTEM STABI LITY	SETTLING TIME PERIO D
TCSC	LESS EFFECTIVE	4.2
SVC	EFFECTIVE	0.4
UPFC	**MORE EFFECTIVE**	**0.36**

5. CONCLUSIONS

In this paper, the ability system stability sweetening of an influence system by varied FACTS devices is bestowed and mentioned. the ability stability of the system is compared with totally different FACTS devices. The performance of the UPFC for installation stability improvement is healthier compared with the opposite FACTS devices like SVC, TCSC, that is obvious from the simulation results and there's a substantial improvement of the system stability with UPFC. The essential options of FACTS controllers and their potential to enhance system stability is that the prime concern for effective & economic operation of the ability system

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