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Research Paper Engineering

Coordination Of Pss And Statcom To Enhance The Power System Transient Stability

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ABSTRACT

In this paper Power System Stabilizer (PSS) and Static Synchronous Compensator (STATCOM) is used to enhance the power system transient stability. The combination of PSS and STATCOM is effectively implemented on the IEEE 9 bus system dynamic benchmark. The standard Newton-Raphson method is used to solve the nonlinear power flow equation and integration method used is trapezoidal method. Simulation of studies stated above is implemented using MATLAB/PSAT software. ABSTRACT— In this paper Power System Stabilizer (PSS) and Static Synchronous Compensator (STATCOM) is used to enhance the power system transient stability. The combination of PSS and STATCOM is effectively implemented on the IEEE 9 bus system dynamic benchmark. The standard Newton-Raphson method is used to solve the nonlinear power flow equation and integration method used is trapezoidal method. Simulation of studies stated above is implemented using MATLAB/PSAT software.

Keywords : Transient stability Analysis, PSS, STATCOM

I. INTRODUCTION

Now a days transmission network of modern power systems are becoming increasingly stressed because of growing demand and restrictions on building new lines and generating units. One of the consequences of such a stressed system is the threat of losing stability following a disturbance. Flexible ac transmission system (FACTS) devices are found to be every effective in stressing a transmission network for better utilization of its existing facilities without sacrificing the desired stability margin. Flexible AC Transmission System (FACTS) controller such as Static Synchronous Compensator (STATCOM) and the Power System Stabilizer (PSS), employ the latest technology of power electronic switching devices in electric power transmission systems to play an important role as a stability aid for and transient disturbances in an interconnected power systems.

Objective of this paper is to enhancing the power system transient stability with coordination of PSS and STATCOM. In this paper, study mainly focus on the rotor angle and eigen value analysis of the system.

In section (II) of this paper basic of the power system transient stability is represented, in section (III) the basic of STATCOM construction and function is represented, in section (IV) function of PSS in power system is represented. While in section (V) the study is implemented on IEEE 9 bus system dynamic benchmark. The results are presented in section (VI) and finally the conclusion is discussed in section (VII).

II. TRANSIENT STSBILITY

In this paper we are mainly focusing on the TRANSIENT STABILITY, Which is also called the rotor angle stability. Define as:

"Transient Stability is the ability of the power system to maintain synchronism when subjected to sever transient disturbance such as a fault on transmission facilities, loss of generation, or loss of a generator rotor angles, power flows, bus voltage and other system variables". Stability is influenced by the nonlinear characteristics of the power system. If the resulting angular separation between the machines in the system remains within certain bounds, the system maintains synchronism.

Generalized block diagram of power system for transient stability analysis is represented in fig. 1.

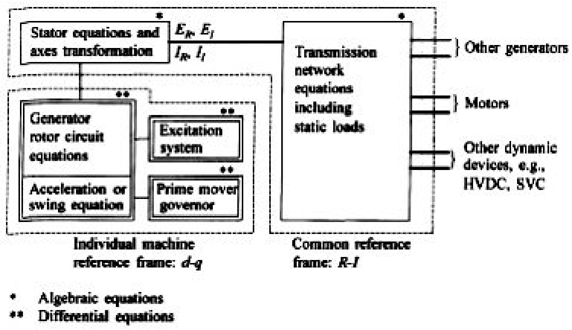


Fig. 1. Generalized structure for transient stability analysis

As seen in fig.1,the overall power system represented includes models for the following individual components:

- Synchronous generators and the associated excitation systems and prime movers.
- Interconnecting transmission network including static loads.
- Induction and synchronous motor loads.
- Other dynamic devices such as HVDC converters and FACTS devices such as SVC, STATCOM,etc.

The model used for each component should be appropriate for transient stability analysis, and the system equations must be organized in a form suitable for applying numerical methods.

Simply the transient stability means the system must be maintain synchronism after the transient fault in the power system.

III. STATCOM

The STATCOM (or SSC) is a shunt-connected reactive-power compensation device that is capable of generating and/ or absorbing reactive power and in which the output can be varied to control the specific parameters of an electric EMERGING FACTS CONTROLLERS of power system. Function of the STATCOM is similar as the Synchronous condenser. But it's controlling is different than synchronous condenser. It is in general a solid-state switching converter capable of generating or absorbing independently controllable real and reactive power at its output terminals when it is fed from an energy source or energy-storage device at its input terminals.

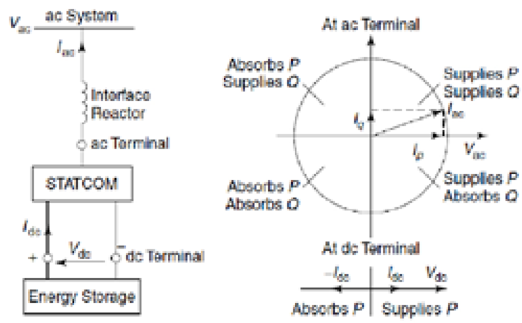


Fig. 2. Power circuit and power exchange of STACOM

A STATCOM provides the desired reactive power by exchanging the instantaneous reactive power among the phases of the ac system as shown in Fig.2. The mechanism by which the converter internally generates and/ or absorbs the reactive power can be understood by considering the relationship between the output and input powers of the converter. The converter switches connect the dc-input circuit directly to the ac-output circuit. Thus the net instantaneous power at the ac output terminals must always be equal to the net instantaneous power at the dc-input terminals.

IV. Power System Stabilizer (PSS)

The basic function of a power System Stabilizer is to add damping to the generator rotor oscillations by controlling its excitation using auxiliary stabilizing signal. To provide damping, the stabilizer must produce a component of electrical torque in phase with the rotor speed deviation (Δδ).

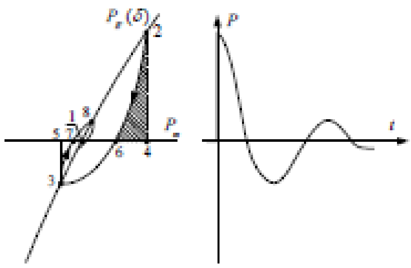


Fig. 3. Power oscillation due to effect of PSS

However, in practice both the generator and the exciter (depending on its type) exhibit frequency dependent gain and phase characteristics. So, PSS should have appropriate phase compensation circuits to compensate for the phase lag between the exciter input and the electric torque. In ideal case, the phase characteristic of PSS being an exact inverse of the exciter and generator phase characteristics to be compensated, the PSS would result in a pure damping torque at all oscillating frequencies.

V. SIMULATION DIAGRAM:

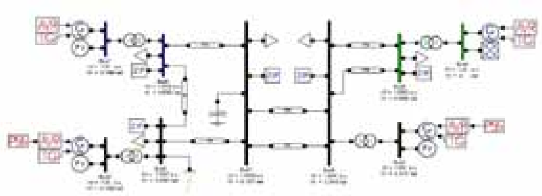


Fig. 4. IEEE 9 bus system dynamic benchmark model.

VI. SIMULATION RESULTS

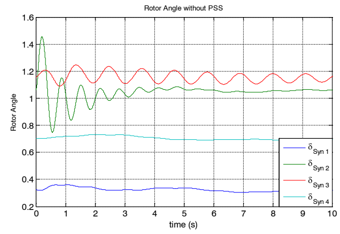
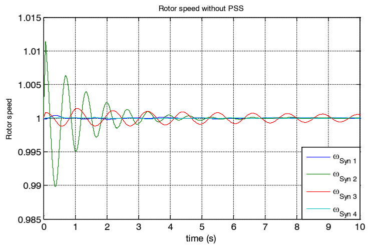
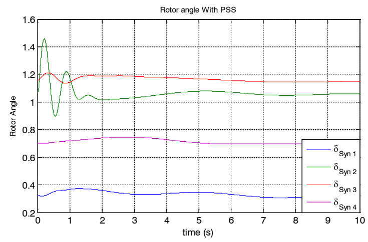


Fig. 5. Rotor angle and rotor speed deviation without PSS





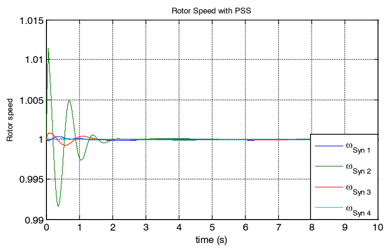
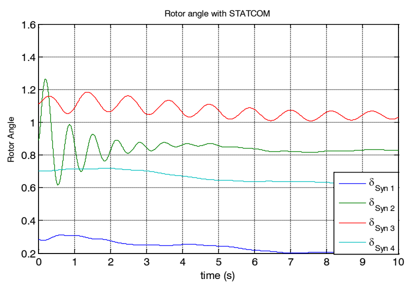


Fig. 6 Rotor angle and rotor speed deviation without PSS



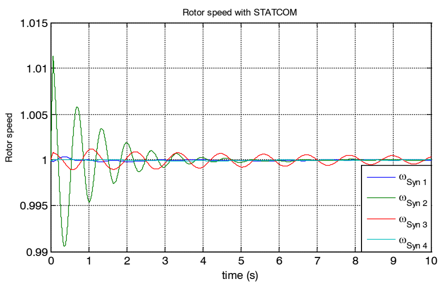


Fig. 7. Rotor angle and rotor speed deviation with STATCOM

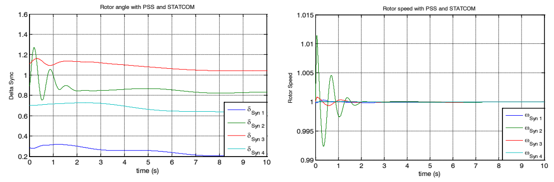


Fig. 8 Rotor angle and rotor speed deviation with PSS and STATCOM

Table. 1 Comparison of Rotor angle and Rotor speed deviation

Rotor angle deviation					
	δ1	δ2	δ3	δ4	Setteling Time(s)
Without PSS	0.326	1.065	1.161	0.702	-
With PSS	0.322	1.062	1.158	0.705	1.2
With STATCOM	0.21	0.829	1.043	0.634	-
With PSS and STATCOM	0.21	0.831	1.028	0.632	1

Rotor Speed deviation				
	W1	W2	W3	W4
Without PSS	0.326	1.065	1.161	0.705
With PSS	0.322	1.062	1.158	0.702
With STATCOM	0.21	0.831	1.043	0.634
With PSS and STATCOM	0.21	0.829	1.028	0.632

From the above simulation the system with only PSS is become steady in 1.2 Sec approximately after fault. With the coordination of PSS and STATCOM system become stable in approximate 1 Sec.

VII. CONCLUSION AND FUTURE WORK

So, that with the PSS and STATCOM, the transient stability of the power system will be enhance. Also reactive power generation will be increased.

APPENDIX

```
Bus.con = [ ...
 1 20 1 0 2 1;
 2 20 1 0 1 1;
 3 20 1 0 1 1;
 4 20 1 0 3 1;
 5 400 1 0 2 1;
 6 400 1 0 1 1;
 7 400 1 0 1 1;
 8 400 1 0 1 1;
 9 400 1 0 3 1;
];
Line.con = [ ...
 5 7 100 400 60 0 0 0.003618 0.024241 1.767004 0 0 0 0 0 1;
 6 7 100 400 60 0 0 0.003618 0.024241 1.767004 0 0 0 0 0 1;
 5 6 100 400 60 0 0 0.003226 0.020851 1.449019 0 0 0 0 0 1;
 7 8 100 400 60 0 0 0.003226 0.069502 1.449019 0 0 0 0 0 1;
 7 8 100 400 60 0 0 0.003226 0.069502 1.449019 0 0 0 0 0 1;
 8 9 100 400 60 0 0 0.003226 0.069502 1.449019 0 0 0 0 0 1;
 8 9 100 400 60 0 0 0.003226 0.069502 1.449019 0 0 0 0 0 1;
 1 5 100 20 60 0 0.05 0 0.0002 0 0 0 0 0 0 1;
 2 6 100 20 60 0 0.05 0 0.0066 0 0 0 0 0 0 1;
 3 8 100 20 60 0 0.05 0 0.002 0 0 0 0 0 0 1;
 4 9 100 20 60 0 0.05 0 0.000143 0 0 0 0 0 0 1;
 ];
Fault.con = [ ...
 6 100 400 60 0 0.06666667 0 1e-006;
 ];
Shunt.con = [ ...
 7 100 400 60 0 8.099986 1;
 ];
SW.con = [ ...
 4 100 20 1.02 0 1.5 -1.5 1.1 0.9 0.8 1 1 1;
 ];
PV.con = [ ...
 1 100 20 410 1.03 0.8 -0.2 1.1 0.9 1 1;
 2 100 20 12 1.05 0.8 -0.2 1.1 0.9 1 1;
 3 100 20 37.801 1.032 0.8 -0.2 1.1 0.9 1 1;
 ];
PQ.con = [ ...
 5 100 400 400 80 1.2 0.8 1 1;
 7 100 400 27.5 5.5 1.2 0.8 1 1;
 8 100 400 17.5 2 1.2 0.8 1 1;
 9 100 400 500 120 1.2 0.8 1 1;
 6 100 400 5 1 1.2 0.8 1 1;
 ];
Pl.con = [ ...
 5 100 400 60 0 0 100 0 0 100 1 1;
 9 100 400 60 0 0 100 0 0 100 1 1;
 6 100 400 60 0 100 0 0 100 0 1 1;
 8 100 400 60 0 100 0 0 100 0 1 1;
 7 100 400 60 0 100 0 0 100 0 1 1;
 ];

Syn.con = [ ...
 1 60000 20 60 2 0 0.0046 2.11 0.28 0.215 4.2 0.032 2.02
0.49 0.215 0.565 0.062 4.636 2 0 0 1 1 0 0 0 1 1;
 2 1300 20 60 6 0 0.0019 2.183 0.413 0.339 5.69 0.041 2.157
1.285 0.332 1.5 0.144 5.284 2 0 0 1 1 0 0 0 1 1;
 3 4400 20 60 6 0 0.0031 1.7 0.245 0.185 5.9 0.033 1.64 0.38
0.185 0.54 0.076 7.92 2 0 0 1 1 0 0 0 1 1;
 4 70000 20 60 3 0 0.001 1.79 0.22 0.18 4.3 0.032 1.715 0.4
0.215 0.565 0.062 7.86 2 0 0 1 1 0 0 0 1 1;
 ];
Tg.con = [ ...
 1 1 1 0.04 100 0 20 0.2 0.2 0.2 0.2;
 2 1 1 0.04 100 0 20 0.2 0.2 0.2 0.2;
 3 1 1 0.04 100 0 20 0.2 0.2 0.2 0.2;
 4 1 1 0.04 100 0 20 0.2 0.2 0.2 0.2;
 ];

Exc.con = [ ...
 1 3 100 -100 100 3 1 1 0 0.4 0.04 0.0006 0.9 1;
 2 1 4 -4 200 4 1 0.006 0.06 0.0001 0.0001 0 0 1;
 3 1 4 -4 200 4 1 0.006 0.06 0.0001 0.0001 0 0 1;
 4 3 100 -100 100 3 1 1 0 0.4 0.04 0.0006 0.9 1;
 ];
Pss.con = [ ...
 2 2 1 0.1 -0.1 15 10 0.1 0.01 0.12 0.01 25 0.5 20 5 0.045
0.045 0.045 -0.045 1 0.95 0 1;
 3 2 1 0.1 -0.1 20 10 0.1 0.01 0.12 0.01 25 0.5 20 5 0.045
0.045 0.045 -0.045 1 0.95 0 1;
 ];

Statcom.con = [ ...
 7 100 400 60 50 0.1 1.2 0.8 1;
 ];

Bus.names = {...
 'Bus1'; 'Bus2'; 'Bus3'; 'Bus4'; 'Bus5';
 'Bus6'; 'Bus7'; 'Bus8'; 'Bus9'};
```

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