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Abbreviations

FACTS	Flexible alternating current transmission system
STATCOM	Static synchronous compensator
VAR	Voltage ampere reactive
SVC	Static var compensator
TCSC	Thyristor controlled series compensator
SSSC	Static synchronous series compensator
UPFC	Unified power flow controller
VSI	Voltage source inverter
PSAT	Power system analysis toolbox
ASVG	Advanced static var generator
GTO	Gate turn-off thyristor
IGBT	Insulated gate bipolar transistor
DC	Direct current
AC	Alternating current
GRP	Glass reinforced plastic
HVDC	High voltage direct current
PWM	Pulse width modulation
D-Statcom	Distribution static synchronous compensator
PCC	Point of common coupling
SPWM	Space pulse width modulation
MVA	Mega volt ampere
IEEE	Institute of electrical and electronic engineers
Bus	Busbar
MW	Mega watt
FCT	Fault clearing time
Mvar	Mega volt ampere reactive
Pu	Per unit
Sec	Second
PI	Proportional Integral

List of Symbols

V_{ac}	AC system bus voltage
I_{ac}	STATCOM output ac current
V_{dc}	Voltage across dc capacitor
V_{out}	AC output voltage
X	Coupling transformer leakage reactance
α	Firing angle
V_{ref}	Reference voltage of STATCOM
P	Active power
Q	Reactive power
V_T	Terminal voltage
V	Voltage
Q_C	Capacitive reactive power
Q_{Cmax}	Maximum capacitive reactive power
P_{nom}	Converter rating in MVA
I_{cmax}	Maximum capacitive current
I_{Lmax}	Maximum inductive current
δ_c	Critical clearing angle
ω	Generator speed
H	Inertia constant
T_m	Mechanical Torque
T_e	Electrical Torque
V_f	Field voltage
i_f	Field current
R_f	Field resistance
δ	Generator power (load) angle
ω	Angular velocity

ψ_F	Field winding flux linkage
ψ_d	d-axis stator flux linkage
V_d	d-axis voltage
i_d	d-axis current
R_d	d-axis resistance
ψ_q	q-axis stator flux linkage
ψ_D	Damper flux linkage
R_D	Damper resistance
i_D	Damper current
ψ_q	q-axis flux linkage
V_q	q-axis voltage
i_q	q-axis current
R_q	q-axis resistance
ψ_Q	Q-winding flux linkage
R_Q	Q-winding resistance
i_Q	Q-winding current
V_Q	Q-winding voltage
L_d	d-axis synchronous inductance
L_q	q-axis synchronous inductance
L_F	Field synchronous inductance
M_F	Field mutual inductance
M_D	Damper mutual inductance
M_Q	Q-winding mutual inductance
M_{FD}	Mutual inductance between field and damper windings
T_A, T_F	Time constants in the excitation system
E_{fd}	Exciter output voltage
V_{ref}	Reference voltage
K_A	Gain of the voltage regulator amplifier
K_F	Regulator stabilizer circuit gain
E_{max}	Maximum value of E
E_{min}	Minimum value of E

V_{pcc}	Point of common coupling voltage
V_{stat}	STATCOM voltage
M	Modulation index
T_w, T_1, T_3	Hydro-turbine time constants
P_{ref}	Reference power
P_{max}	Maximum value of P
P_{min}	Minimum value of P
P_m	Mechanical power
i_{sd}	STATCOM current in d-axis
i_{sq}	STATCOM current in q-axis
v_{dstat}	STATCOM voltage in d-axis
v_{qstat}	STATCOM voltage in q-axis
v_{dpcc}	Point of common coupling voltage in d axis
v_{qpcc}	Point of common coupling voltage in q axis
i_{sd}^*	STATCOM reference current in d axis
i_{sq}^*	STATCOM reference current in q axis
K_{pi}	Proportional gain
K_{ii}	Integral gain
K_{pdc}, K_{idc}	Proptional and integral gains of the DC voltage controller.
K_{pac}, K_{iac}	Propotional and integral gains of the AC voltage controller
V_{dc}^*	DC voltage reference
$V_1 - V_6$	Non zero output voltage
$V_0 - V_7$	Zero vectors
V_s^*	Voltage in a stationary (α - β axis) reference frame
V_k, V_{k+1}	The adjacent active vectors
T_s	Sampling time
T_0	Time for zero state
$W1$	Speed of machine 1
$W2$	Speed of machine 2
V_{t1}	Terminal voltage of machine 1
V_{t2}	Terminal voltage of machine 2

V_{meas}	Measured voltage of STATCOM
δ_{12}	Generator 2 load angle measured with respect to generator 1 load angle
δ_{13}	Generator 3 load angle measured with respect to generator 1 load angle
ω_{12}	Generator 2 speed measured with respect to generator 1 speed
ω_{13}	Generator 3 speed measured with respect to generator 1 speed

Abstract

Transient stability is the ability of power system to maintain synchronism when subjected to a severe disturbance such as three phase fault on transmission line or large increase in load or loss of large load. Static synchronous compensator (STATCOM) is one of the FACTS devices used to improve the transient stability of the power system. It regulates voltage at its terminal by controlling the amount of reactive power injected into or absorbed from power system.

In this thesis the ability of STATCOM to improve the transient stability has been studied. Firstly two machine system under three phase fault is considered. The system is simulated using MATLAB/SIMULINK environment, then STATCOM of 200 MVA is implemented in the system to study its effect in improving the transient stability, after that the two machine system with step changing load is simulated in two steps without STATCOM and with STATCOM then the STATCOM damping characteristics have been analyzed. Secondly the study has been extended to a multi-machine system and IEEE 3-machine 9 bus system is taken as case study. The simulation is carried out using PSAT software. At the beginning the system has been simulated under fault and without STATCOM. Then STATCOM is installed in the system and its ability to enhance the transient stability has been investigated.

المستخلص

الاستقراريه العابره هي مقدرة نظام القدره للمحافظه على التزامن عند تعرضه للاضطراب الشديد مثل الاعطال ثلاثية الاطوار على خط النقل او الزياده او النقصان في الاحمال الكبيره. المعوض التزامني يعتبر احد ادوات ال FACTS التي تستخدم لتحسين الاستقراريه العابره لنظام القدره. فهو يقوم بتنظيم الجهد بالتحكم في كمية القدره المحقونه او الممتصه من نظام القدره.

في هذا البحث تم دراسة قدرة المعوض التزامني الساكن لتحسين الاستقراريه العابره لنظام القدره. اولا تم دراسة ماكنتين تحت تأثير عطل ثلاثي الطور. تم محاكاة النظام باستخدام برنامج Matlab/Simulink ثم وصل معوض تزامني ساكن 200 MVA مع النظام لدراسة تأثيره على الاستقراريه العابره. بعد ذلك تم محاكاة نظام الماكنتين مع حمل متغير بخطوه ثابته بدون باستخدام وبدون استخدام المعوض التزامني الساكن ثم تم تحليل خصائص الاخماد للمعوض التزامني الساكن. ثانيا تم توسيع الدراسه لتشمل النظام المتعدد الماكينات حيث تم اخذ نظام IEEE ثلاثه ماكينات، 9 موصلات عموميه كنموذج للدراسه. تم محاكاة النظام باستخدام PSAT. في البدايه تم محاكاة النظام عند عطل ثلاثي الطور وبدون استخدام المعوض التزامني الساكن. وبعد ذلك تم استخدام المعوض التزامني الساكن وتم التحقق من مقدرته على تحسين الاستقراريه العابره.