ORIGINAL PAPER



ADRC-based control strategies to alleviate SSR using STATCOM

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Abstract

Increasing prominence of series compensation into the power system has evidently enhanced the rise of subsynchronous resonance (SSR). Alleviation of SSR with two novel control designs for static synchronous compensator (STATCOM) is proposed in this paper. Since it is quite challenging to optimize proportional and integral (PI) controllers in a nonlinear framework, hence a nonlinear active disturbance rejection controller (ADRC)-based strategies are proposed. First control design is template-based ADRC (TADRC), and the second control design is synchronous ADRC (SADRC). To validate the effectiveness of control schemes, an IEEE second benchmark model is used. Furthermore, different analyses are demonstrated to study the phenomenon of SSR. Firstly, the state space model-based design is provided for eigenvalue analysis. Fast Fourier transform (FFT) analysis is also carried out to show the dominant mode of oscillations along with the frequency scan at various levels of compensation. Finally, trends in generator speed and other parameters are shown in the time domain analysis of the system. The analyses and measures to alleviate the oscillations proposed in this paper are eminently cogent.

EXM

Keywords SSR · FACTS · STATCOM · ADRC control · Torsional oscillations · Frequency scan

List of symbols

Δ	Small deviation when used as prefix
δ	Load angle in rad/s
$\Delta \delta$	Angle of twist of mass
$\Delta \omega$	Deviation in speed of mass in pu
ω	Rotor speed in pu
ω_0	Speed (rated) in electrical rad/s
Ψ	Flux linkage in pu
τ	Torques in turbine sections
	Differential operator
bb	Infinite bus when subscript
cd	Capacitive and d-axis when subscript
cq	Capacitive and q-axis when subscript
D	Coefficient of damping in pu torque/pu speed devi-
	ation
d	d-axis when subscript
ds	Damper winding on q-axis when subscript
dw	Damper winding on d-axis when subscript
e,E	Voltage at sending end in pu
	N/ C

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Fτ Torques in fractions fd Field winding when subscript GM Generator when subscript GXM Excitation and generator when subscript

Excitation when subscript

- HLM High pressure and low pressure when subscript
- HPM High pressure turbine when subscript
- Current in pu i
- Κ Stiffness in pu torque/electrical rad
- K_{GVNR} Governor system gain constant
- Transmission line when subscript. L
- LGM Low pressure turbine and generator when subscript
- LPM Low pressure turbine when subscript
- Constant of inertia in MW.s²/rad Μ
- Mutual and d-axis when subscript md
- Mutual and q-axis when subscript mq
- O_{GVNR} Opening of governor
- O_{SRP} Speed relay position
- q-axis when subscript q
- Damper winding on q-axis when subscript qw
- Resistance in pu r.R
- rw Armature winding when subscript
- Rx Regulation by excitation system when subscript
- t0 Terminal base value when subscript
- T_A Excitation due to regulation time constant

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