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ROTATING ELECTRICAL MACHINES

10789_2022

An innovative power system stabilization method with augmented inertia synchronous condensers

G. M. Giannuzzi, F. Palone, C. Pisani, R. Zaottini, R. Puddu, B. Aluisio

TernaS.p.A.

Motivation

The increase of renewable energy, the decrease of power plants from conventional sources, the decrease of inertia and a greater angular displacement between the nodes of the network can cause a decrease in damping associated with low-frequency oscillations at levels considered insufficient for the safe operation of the grid.

Method/Approach

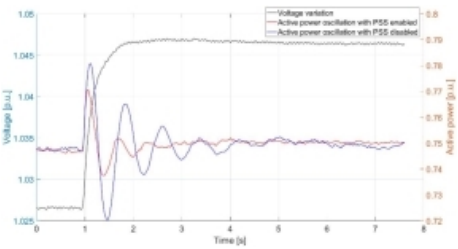
Power system stability is historically addressed by Terna by Power System Stabilizer (PSS), which, using a local signal, provides a damping contribution toward both local and interarea oscillations. As a joint action together with PSSs toward inter-area oscillations, a Wide Area Damping Control (WADC) have been recently developed for Synchronous Condensers (SCs). This innovative control exploits Phasor Measurement Units (PMUs) to process an area-based stabilizing signal.

Objects of investigation

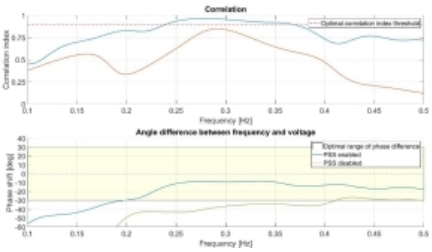
All methodologies for optimization and verification of PSS installed in Italian Grid are discussed and aim to contribute to the architecture of the WADC system designed by Terna. The architecture of the WADC system describes application in SCs that will soon be put into service in some stations of the Italian electric system.

Experimental setup & test results

PSS settings are agreed with the Italian TSO either through periodically checked during power plant inspections and tests or through tests related to the upgrading of the excitation systems or PSS.



The magnitude of the step is 2 % of the nominal voltage and the traces in red and blue represent the response with PSS disabled and the one with PSS enabled with parametrization designed by Terna, respectively.



Discussion

As shown in the **first figure** applying a step on the voltage reference of the synchronous generator Automatic Voltage Regulator (AVR) and collecting the active power response for successive assessment of the damping. It can be noted that with Terna finetuning the damping ratio of the excited oscillation mode is practically doubled: from 12.5 % without PSS to 23.6 % with PSS. PSS tries to compensate the phase shifting introduced by the excitation voltage that has an inherent unstable action on the synchronous generator electromagnetic torque. The goodness of its performance can be assessed in the **second figure** by looking how the PSS allows to minimize phase shifting between frequency and voltage on the typical frequency of the electromechanical oscillations.

Conclusion

Further installations of SCs on the Italian grid are planned during 2022 and successive years. During the commissioning phases, the PSS will be appropriately calibrated and tested. Following the first promising results, WADC will be also released on other electrical machines scheduled to entry into service.